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OPERATIONS AND MAINTENANCE MANUAL
FOR EXPANDED BIOVENTING SYSTEM
SITE FC-2
KELLY AFB, TEXAS

Prepared for:
AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE
BROOKS AFB, TEXAS

AND

SAN ANTONIO AIR LOGISTICS CENTER/EMR
KELLY AFB, TEXAS

MARCH 1996

Prepared by:
PARSONS ENGINEERING SCIENCE, INC.
DENVER, COLORADO

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March 11, 1996

Via U.S. Mail

Lt. Maryann Jenner
AFCEE/ERT
8001 Arnold Drive
Brooks AFB, TX 78235-5357

Subject: Transmittal of Revised Operations and Maintenance Manual and
Summary of initial sampling results at Site FC-2, Revision 01
San Antonio Air Logistics Center-Kelly AFB, Texas
USAF Contract 41624-92-D-8036, Delivery order 17

Dear Lt. Jenner:

This letter transmits three revised copies of the Operations and Maintenance (O&M) Manual for the six vent well (VW) system installed at Site FC-2 at Kelly AFB, discusses the initial results of soil and soil gas sampling, and summarizes the findings of initial optimization testing. This letter also notifies you that six additional copies of the O&M Manual prepared for the six vent well system installed at Site FC-2 have been submitted to Eupi Quinones at Kelly AFB. Attachment A of the O&M Manual contains "As-Built" design drawings for the installed system; attachment B includes blower specifications and information; attachment C are data collection sheets for periodic monitoring of the blower performance; and attachment D includes documentation required for the application of an air emissions standard exemption. This letter also provides a summary of calculated potential air emissions based on the initial sampling results and lists the current operating parameters of blower system.

This revised letter is not intended to fulfill any of the reporting requirements of the bioventing remedial action initiated at Site FC-2, but rather is intended to document the status of the site following initial optimization testing. The location of VW-04 in the As-Built drawing has been changed to more accurately reflect its location relative to other installed structures at the site. Our air emission assessment suggests that air injection rates of up to 25 cubic feet per minute meet applicable standard exemption requirements. However, Duncan Shields of the Texas Natural Resource Conservation Commission (TNRCC) Air Quality Division has recently indicated that air injection bioventing treatment systems do not need the exemption application to be submitted because there are no potential for emissions from a point source. We have provided the air emissions data to document that potential air quality impacts of the operating system have been addressed.

Information regarding initial contaminant levels in soils and soil gas, potential air emissions, and operating parameters are described in the following subsections.

Summary of initial sampling results

Five soil samples were collected and analyzed for benzene, toluene, ethyl benzene, and xylene (BTEX), polynuclear aromatic hydrocarbons (PAHs), and total petroleum hydrocarbons (TPH). Five soil gas samples were also collected and analyzed for BTEX and TPH. The analytical results are presented in the two tables attached to this letter. Twenty-six soil gas samples were also collected to perform field screening analyses. These samples were field screened for oxygen, carbon dioxide, and total volatile hydrocarbons. The results of these measurements are also included on the attached soil gas data table. The respective locations for the samples can be found in the design package included as attachment A of the O&M Manual. The sample depths, if applicable, can be determined from the sample identification code. The greatest soil contamination was encountered in the soil sample collected in Vent Well 6 at a depth of 13 feet below ground level (VW#2, 13). Low oxygen readings, which are usually indicative of contaminated soils, were identified in the deeper sampling intervals of MPC, MPD, and MPE, and in the screened interval of VW#2. This data supports the conclusion that the contaminant plume is centered around VW#2 and extends from the southeastern edge of the old simulated aircraft to near the edge of the topographic relief encountered in the southeastern edge of the site. The vent well placement appears to be appropriate to address most, if not all contaminated soils at the site.

A half-inch of free product was encountered in monitoring well FT024-MW002 during the initial sample collection activities performed on January 17, 1996. This well is located adjacent to vent well 2. A sample of this free product was collected and analyzed for BTEX and PAHs. No PAHs were detected above the detection limit of 99 milligrams per liter (mg/L), but 1240 mg/L benzene and 1510 mg/L total BTEX were detected.

Air emission summary

The Texas Clean Air Act requires permitting of any emitter of pollutants to the atmosphere. The Act is implemented through 30 TAC Chapter 116, "Control of Air Pollutants By Permits for New Construction or Modification". Bioventing systems provide oxygen to microorganisms within soils, which result in the emission of VOC through the displacement of the air pore volume in the remediated soils. Generally, most Bioventing systems involve very low air pollution emissions rates allowing them to be exempted, as outlined in 30 TAC 116.211, under Standard Exemption 68. Standard Exemption 68 incorporates portions of Standard Exemptions No. 80, 88, and 118. Recent communications with the TNRCC indicate that the exemption may not need to be filed if the treatment system is operated by injection of air into soils.

Standard Exemption 68 is applicable for "Equipment used to reclaim or destroy chemicals removed from contaminated materials for the purpose of a remedial action". Its provisions allow air emissions of total petroleum hydrocarbon (TPH) of one pound per hour, with or without abatement devices. An emissions limit formula in Standard Exemption 118, Section (c), is used to determine maximum allowable emissions rates for chemicals other than petroleum fuels. The exemption only applies to on-site remediation. Mr. Shields stated that the TNRCC applies the exemption requirement for point source emissions, such as air extraction treatment systems. Part 68(e) provides technical

conditions to be met when abatement is required to meet the specific chemical emission limit.

The bioventing system installed at Kelly AFB will diffuse VOCs, specifically benzene and TPH, from surrounding soils. Organic compound emissions from the bioventing project were calculated using the emission factor for soil remediation contained in the Technical Guidance Package for Soil Remediation, TNRCC publication dated October 1995. Analysis of soil gas samples taken from contaminated soils revealed the presence of hydrocarbons at the following average soil gas concentrations of contaminants:

Chemical Compound	Average Soil Gas Concentration (ppmv)
Benzene	7.5
TPH	1338.2

Initial diffusion of vapors within the soil matrix were estimated at an anticipated average flow rate of 11 standard cubic feet per minute (scfm). This flow rate was intended to maximize the delivery of oxygen to contaminated soils while minimizing the mass of contaminants available for displacement to the atmosphere caused by air injection. Recent optimization testing has indicated that 11 scfm is not sufficient to increase oxygen in anaerobic soils greater 15 feet from the injection point. Parsons ES intends to increase the air injection flow rate to approximately 25 scfm on March 13, 1996. Additional testing to determine if the increased flow rate is delivering oxygen to anaerobic portions of the subsurface soils is tentatively planned for early April 1996.

Under worst case conditions all of the chemical vapors in the soil pore volume would be displaced to the atmosphere. The worst case emission would take place during the first pore volume displacement and would result in a 0.38 LB/hr discharge of TPH and a 0.001 LB/hr discharge of benzene. Because the initial pore volume will contain the highest volatile concentrations, the rate of emissions from the soils will decrease significantly over a period of time.

The bioventing system operating at Kelly AFB satisfies the requirements of Standard Exemption No. 68. Although apparently not required by the TNRCC, documentation required for submittal of the standard exemption application for this site is provided in attachment D of the O&M Manual. This documentation has been provided to demonstrate that under worst case conditions, air emissions will not exceed the exemption criteria.

Current operating parameters

Air injection was initiated at Site FC-2 at 1100 hours (11:00 a.m.) on 26 January 1996. The blower was permitted to run continuously for two hours before adjusting the air injection flow rates. Positive pressure was observed at each of the vent wells indicating that the underground pipeline conduits are not obstructed and are delivering injected air to each of the vent wells. Flow to each of the vent wells was adjusted after 1300 hours (1:00 p.m.) to maintain flow rates in each well near 10 cubic feet per minute (cfm). Approximately 70 cfm was being bled off through the bleed valve to reduce the flow the

Lt. Jenner
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vent wells. The final measured flow rates to each of the vent wells measured at 1400 hours (2:00 p.m.) are listed below:

Vent Well 1	9.2 cfm	Vent Well 2	12.3 cfm
Vent Well 3	9.2 cfm	Vent Well 4	12.3 cfm
Vent Well 5	11.0 cfm	Vent Well 6	11.0 cfm

Air injection was measured again on March 6, 1996, and the respective flow rates were within 3 cfm of the January 26 rates, and ranged from 10.5 to 13.5 cfm. Oxygen levels in the soil gas were measured and found to be relatively unchanged from the initial soil gas readings, and actually reduced in numerous points. For example, MPD-4 and MPD-9 were both reduced from 17 and 4 percent to zero percent. Increasing the rate of air injection will have a positive effect on the oxygen influence of subsurface soils.

If you have any questions regarding the information contained in this letter, or if you have any comments on the system installation, please contact me at 512/719-6000 or John Ratz at 303/831-8100.

Sincerely,



Brian Vanderglas, C.P.S.S.
Site Manager

enclosure

cc: John Ratz, Project Manager
Eupi Quinones, Kelly AFB

Soil Samples Analytical Results
Kelly AFB, Site FC-2

	Sample Identification Number				
	VW#2, 14-15	VW#6, 13	MPE 12-14	MPF 11-12	MPD 8-9
BTEX (µg/Kg)					
Benzene	48.1	8,720	< 2.0	< 2.0	280
Toluene	< 10	< 200	< 2.0	< 2.0	341
Ethyl benzene	< 10	740	< 2.0	< 2.0	< 100
Xylenes	< 10	1,360	< 2.0	< 2.0	773
BTEX (total):	48.1	10,800	< 2.0	< 2.0	1,390
PAH (mg/Kg)					
Acenaphthene	< 3.30	< 3.30	< 3.30	< 3.30	< 3.30
Acenaphthylene	< 3.30	< 3.30	< 3.30	< 3.30	< 3.30
Anthracene	< 3.30	< 3.30	< 3.30	< 3.30	< 3.30
Benzo(a)anthracene	< 3.30	< 3.30	< 3.30	< 3.30	< 3.30
Benzo (b)and/or(k)fluoranthene	< 3.30	< 3.30	< 3.30	< 3.30	< 3.30
Benzo(g,h,i)perylene	< 3.30	< 3.30	< 3.30	< 3.30	< 3.30
Benzo(a)pyrene	< 3.30	< 3.30	< 3.30	< 3.30	< 3.30
Chrysene	< 3.30	< 3.30	< 3.30	< 3.30	< 3.30
Dibenz(a,h)anthracene	< 3.30	< 3.30	< 3.30	< 3.30	< 3.30
Fluoranthene	< 3.30	< 3.30	< 3.30	< 3.30	< 3.30
Fluorene	< 3.30	< 3.30	< 3.30	< 3.30	< 3.30
Indeno(1,2,3-cd)pyrene	< 3.30	< 3.30	< 3.30	< 3.30	< 3.30
Naphthalene	< 3.30	< 3.30	< 3.30	< 3.30	< 3.30
Phenanthrene	< 3.30	< 3.30	< 3.30	< 3.30	< 3.30
Pyrene	< 3.30	< 3.30	< 3.30	< 3.30	< 3.30
TPH (mg/kg)					
Extractable	1,020	83	1,550	111	2,360
Volatile	1.84	238	< 0.050	< 0.050	31.20

**Soil Gas Analytical Results
Kelly AFB, Site FC-2**

	Initial Field Screening Data ¹				Laboratory Data				Optimization ² Field Data	
	Purge Time	O ₂ %	CO ₂ %	Field TVH (ppmv)	Benzene (ppmv)	Toluene (ppmv)	Ethyl Benzene (ppmv)	Total Xylene (ppmv)	TPH (ppmv)	O ₂ %
VW 1	5 min	6.5	10	450	NS ³	NS	NS	NS	NS	-
VW 2	1.3 min	0	13	400	NS	NS	NS	NS	NS	-
VW 3	5 min	5.5	11	400	NS	NS	NS	NS	NS	-
VW 4	7 min	14	11	900	NS	NS	NS	NS	NS	-
VW 5	6 min	16	4	300	NS	NS	NS	NS	NS	-
VW 6	5 min	13	7	500	NS	NS	NS	NS	NS	-
MPA-4	30 sec	15	4	200	NS	NS	NS	NS	NS	20.8
MPA-9	30 sec	9	9	200	NS	NS	NS	NS	NS	19.5
MPA-13	30 sec	10	3	450	NS	NS	NS	NS	NS	13
MPB-4	30 sec	16	4.5	150	NS	NS	NS	NS	NS	16.5
MPB-9	30 sec	1	12	300	NS	NS	NS	NS	NS	4.5
MPB-13.5	30 sec	18	1	150	NS	NS	NS	NS	NS	0.5
MPC-4	30 sec	17.5	2.5	100	NS	NS	NS	NS	NS	6
MPC-9	30 sec	0	15	5000	NS	NS	NS	NS	NS	0
MPC-13.5	30 sec	0	15	> 10,000	NS	NS	NS	NS	NS	0
MPD-4	30 sec	17	2.5	1000	0.3	0.14	0.036	0.58	97	0
MPD-9	30 sec	4	5	1100	NS	NS	NS	NS	NS	0
MPD-13.5	30 sec	0	15	5000	37	5.2	1.4	3.2	6300	0
MPE-4	30 sec	15	5	20	0.005	0.009	0.003	0.12	14	8
MPE-9	30 sec	4	8.5	40	0.21	0.22	< 0.18	0.43	170	11.5
MPE-13.5	30 sec	1	14	80	0.067	0.13	< 0.022	1.1	110	11
MPF-4	30 sec	19	1.5	40	NS	NS	NS	NS	NS	20.8
MPF-9	30 sec	5	8.5	100	NS	NS	NS	NS	NS	16
MPF-13.5	H ₂ O ⁴	H ₂ O	H ₂ O	H ₂ O	NS	NS	NS	NS	NS	1.5
FT024/MW003	1 min	0	13	500	NS	NS	NS	NS	NS	-
FT024/MW002	5 min	1.5	16	6000	NS	NS	NS	NS	NS	-
F204	3 min	15.5	4.5	300	NS	NS	NS	NS	NS	-

¹ Data collected on January 17, 1996

² Data collected on March 6, 1996, after 3 weeks of continuous air injection at approximately 11 cfm

³ NS - No laboratory sample collected

⁴ Monitoring point interval saturated with water

NS - No Laboratory Sample Collected

OPERATIONS AND MAINTENANCE MANUAL
FOR EXPANDED BIOVENTING SYSTEM
SITE FC-2
KELLY AFB, TEXAS

Prepared for:
AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE
BROOKS AFB, TEXAS

AND
SAN ANTONIO AIR LOGISTICS CENTER/EMR
KELLY AFB, TEXAS

MARCH 1996

Prepared by:
PARSONS ENGINEERING SCIENCE, INC.
DENVER, COLORADO

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SECTION 1.0 INTRODUCTION

This Operations and Maintenance Manual has been created as a guide for monitoring and maintaining the performance of the bioventing blower and vent well plumbing at the Fire Training Area (Site FC-2) located at Kelly Air Force Base (AFB).

Bioventing is the forced injection of fresh air, or withdrawal of soil gas, to enhance the supply of oxygen for *in situ* bioremediation. At Site FC-2, one pressure air injection blower unit is used to inject air into the soil, thereby supplying fresh atmospheric air (with approximately 20.8 percent oxygen) to contaminated soils. Once oxygen is provided to the subsurface, existing bacteria aerobically break down fuel residuals. Aerobic biodegradation is much more efficient than anaerobic biodegradation which occurs in soils when the soils are oxygen depleted.

Parsons Engineering Science (Parsons ES) has installed an air injection vent well system consisting of six vent wells at Site FC-2. The blower was started on January 26, 1996 and injected flow rates were adjusted so that the injection rates at each vent well are relatively uniform (9.2 to 12.3 cubic feet per minute).

Upon submittal of this Operations and Maintenance Manual, Kelly AFB personnel will be responsible for routine monitoring of the upgraded bioventing system. Parsons ES will train Kelly AFB personnel on the maintenance requirements of this plan. If significant problems are encountered with the operation of this system, Parsons ES should be notified so appropriate repairs can be made.

SECTION 2.0 SYSTEM DESCRIPTION

2.1 BLOWER SYSTEM

The bioventing system in operation at Site FC-2 consists of one 2.5 horsepower (hp) regenerative blower injecting ambient air into six vent wells with screened intervals from approximately 7 to 17 feet below ground level (bgl). The 65 percent "As-Built" design package is included as attachment A of this manual.

A 2.5 hp regenerative blower was in operation from December 1992 until January 1994 as part of a pilot-study at Site FC-2. This blower fed air to the vent well constructed in soil boring VW-1. A 2.5 hp regenerative blower installed in February 1996, injects air into the six vent wells (VW-1 through VW-6). Table 1 lists the blower configuration summary of the new blower installed in the system.

The blower is equipped with an air filter to remove any particulates which are entrained in the inlet air stream, and several valves and monitoring gauges which are described in the next section. An as-built schematic of the 2.5 hp blower system installed for air injection into the 6 vent wells at Kelly AFB is provided in attachment A. A corresponding blower performance curve for the installed blower, and relevant service information are provided in attachment B. It should be noted that performance of the blower systems will vary with changing site conditions.

2.2 MONITORING GAUGES

The bioventing system is equipped with gauges and ports to evaluate system performance. A vacuum gauge is located in the inlet piping and a pressure gauge in the outlet piping of both blower units. A temperature gauge is located at the outlet of each blower system. The locations of the gauges installed on the blower systems at this site are depicted in figure G.4 of attachment A.

2.3 VENT WELL FLOW PORTS

Flow measurement ports are located in the piping of the six vent wells which are connected to the 2.5 hp blower. These ports are located in the line prior to the flow control valve mounted in the blower shed. These ports allow access to the air stream to measure air velocity in the pipelines. Air injection rates will be adjusted by Parson ES personnel.

Table 1
Blower Configuration Summaries

2.5 Horsepower Blower
System Type: Injection
Blower: Regenerative
Blower Model: Gast R5
Motor: 2.5 (Hp)
Inlet Vacuum Gauge (range): 0 - 60 inches of water
Inlet Filter (part no.): Solberg F-18-150
Outlet Temperature Gauge: 0 - 250° Fahrenheit
Outlet Pressure Gauge (range): 0 - 100 inches of water
Pressure Relief Valve Set at: 40 inches of water

2.4 POWER SUPPLY

The 2.5 hp blower motor is powered by a dedicated 230 volt single phase power source connected to a 100 amp fuse box. Since this area exists in a flood plain, the fuse box and starter box is elevated 4 feet above ground level and is located on the western corner of the blower shed. To ensure safety of personnel and equipment, a qualified electrician will be used for any repairs requiring the dismantle or disconnection of the blowers; or to address electrical supply problems.

SECTION 3.0 SYSTEM MONITORING

3.1 BLOWER PERFORMANCE MONITORING

Vacuum pressure, injection pressure, and injection temperature will be measured as part of the routine monitoring of the blower operations. These data should be recorded at least every two weeks on a data collection sheet (provided in attachment C). All measurements should be taken while the system is running. Because the operating system may be loud, it may be necessary to wear hearing protection when collecting data or monitoring blower performance.

3.2 VACUUM/PRESSURE

To collect blower performance data, open the blower enclosures and record all vacuum and pressure readings directly from the gauges (in inches of water). Record the measurements on a data collection sheet (attachment C).

3.3 BLOWER FLOW RATE

The flow rate from the blower can be calculated when the inlet vacuum and outlet pressure of the blower are known. This pressure change across the blower (vacuum + pressure) can be compared to the performance curves for the blower in Attachment A to determine the approximate flow rate. The flow volume from the manual bleed valve is subtracted from the value obtained from the blower curve to estimate actual injection flow.

3.4 VENT WELL FLOW RATE

In addition to estimating total air flow, air flow entering each of the six adjoined vent wells should be calculated after every start-up of the system. These flow measurements are calculated using direct measurements of in-line air velocity and pipe size data. The six vent wells are designed to allow measurement of air velocity through a small port on the air injection piping.

The following paragraphs detail the equipment and process presently used to measure air velocity and calculate air flow into each injection well:

A Dwyer Thermal Anemometer Series 470 is employed for air velocity measurement. This handheld meter with probe connected by cable for remote measurement has an analog scale with dual velocity ranges (0-600 feet per minute and 500-6000 feet per minute). The unit requires two 9 volt radio batteries for power.

Calibration of the unit is detailed on the carrying case and is completed in seconds with no ancillary equipment or supplies being needed.

To take a measurement, remove the screw plug located in the flow measurement port and insert the anemometer probe tip into the pipeline through the flow measurement port. Measurement is made at the center of the pipe cross-section with the markings on the probe facing parallel to the air flow. With the range selector set in the high range setting, depress the "push to measure" switch to take a reading. After obtaining data, remove the anemometer probe, and replace the screw plug.

An example of air flow calculation follows:

$$Q = V * A$$

Q = flow in cubic feet per minute

V = air velocity in feet per minute

A = area of pipe cross-section in square feet (the 1.5 inch pipes on site are equal to 0.0123 square feet)

With a reading of 1500 feet per minute:

V = 1500 feet per minute

Q = $V * A = (1500.0 \text{ feet per minute}) * (0.0123 \text{ square feet})$

Q = 18.45 cubic feet per minute

Flow into this vent well is 18.45 cubic feet per minute. Repeat process for other five vent wells. Flow at each vent well must be remeasured if any of the flow valves are adjusted during flow measurement event.

3.5 TEMPERATURE

Blower temperature measurements can be measured by reading the temperature readings directly from the gauges in degrees Fahrenheit (°F). Record the measurements on a data collection sheet (provided in attachment C). The temperature change can be converted to degrees Celsius (°C) using the formula $^{\circ}\text{C} = (^{\circ}\text{F} - 32) \times 5/9$.

3.6 MONITORING SCHEDULE

The following monitoring schedule is recommended for this system. During the initial months of operation, more frequent monitoring is recommended to ensure that any start up problems are quickly corrected. Data collection sheets have been provided to assist your data collection and are included in attachment C.

Monitoring Item	Monitoring Frequency
Vacuum/Pressure	Daily during first few days, then at least once every two weeks.
Temperature	Daily during first few days, then at least once every two weeks.
Air Flow (from blower)	After system start up, then, as necessary following repairs or major adjustments to flow.
Air Flow (into each vent well)	After system start up, then, as necessary following repairs or major adjustments to flow.

SECTION 4.0

SYSTEM MAINTENANCE

Although the motor and blower are relatively maintenance free, periodic system maintenance is required for proper operation and long life. Recommended maintenance procedures and schedules are described in detail in the instruction manuals included in attachment B and briefly summarized in this section.

4.1 BLOWER/MOTOR

The blower and motor are relatively maintenance free and should not require any periodic maintenance during the testing period. Both blower and motor have sealed bearings and do not require lubrication. To re-start the motor, open the manual air dilution valve (bleed valve) to protect the motor from excessive strain, start motor, and slowly close dilution valve. If the handle has been removed from the manual air dilution valve, do not open the valve or otherwise change the setting (it has been pre-set for a specific flow rate) before re-starting the blower. If power outages occur, the blower must be reset prior to pushing the restart switch. The blower will not self start when power is restored.

4.2 AIR FILTER

To avoid damage caused by passing solids through the blower, an air filter has been installed in-line before the blower. The filter element is paper and is accompanied by a polyurethane foam prefilter. The filter should be checked weekly for the first 2 months of operation. The best schedule for filter replacement will be determined during biweekly field checks of the system throughout the first year of operation. The polyurethane prefilters can be washed with lukewarm water and a mild detergent. Paper filter elements should never be washed, but should be disposed of and replaced as necessary. When the vacuum pressure across the filter is above 15 inches of water, a dirty filter element should be suspected, and cleaning or replacement should be performed.

Filter inspection must be performed with the system turned off. To remove the filter, loosen the three clamps or the wing nut, lift the metal top off the air filter, and lift the air filter from the metal housing. Remove the polyurethane prefilter (if applicable) and wash before replacing. When replacing the filter, be careful that the rubber seals remain in place.

The filter elements are manufactured by Solberg Manufacturing, Inc. in Itasca, Illinois. Their telephone number is (708) 773-1363. Additional filters can be ordered

through Parsons ES during the first year of operation, as needed. The filter model number is F-18P-150. A spare filter will be supplied with the blower system.

4.3 MAINTENANCE SCHEDULE

The following maintenance schedule is recommended for this system. During the initial months of operation, more frequent monitoring is recommended to ensure that any startup problems are quickly corrected. A daily drive-by inspection is recommended during the initial week of operation to ensure that the blower system is still operating with no unusual sounds. Data collection sheets that can be used to record maintenance activities are included in Attachment B.

<u>Maintenance Item</u>	<u>Maintenance Frequency</u>
Filter replacement	Check at least every other week for first two months of operation, then monthly. Wash polyurethane prefilter when air flow is restricted. Replace paper element when air flow is restricted.
Daily drive-by	Daily during first week after restarting blowers, then at least once per month.

4.4 MAJOR REPAIRS

Blower systems are very reliable when properly maintained. Possible problems which may occur include:

<u>Maintenance Item</u>	<u>Symptom</u>	<u>Action</u>
Motor	Does not start	1. Check circuit breaker, or reset switch. 2. Have electrician check power supply
Blower Motor	Makes noise or smokes	1. Turn power off 2. Call site manager 3. Repair/replace motor
Blower fan (impellers)	Broken or makes noise when operated	1. Turn power off 2. Call site manager 3. Repair/replace blower fan

In the event of any potential fire or safety hazard the blower system should be turned off immediately and the Parsons ES site manager, Brian Vanderglas, should be called at (512) 719-6000. Parsons ES will repair any damage to the blower system during the first year of operation.

SECTION 5.0

SAFETY PLAN

The following items dealing with the FC-2 bioventing system require caution by personnel visiting the site. (1) Due to the use of high voltage power supplies, a qualified electrician should perform all electric work. (2) Hearing protection is recommended for personnel taking readings inside the blower shed.

SECTION 6.0

EXTENDED TESTING OF BIOVENTING SYSTEM AND SITE CONTAMINATION

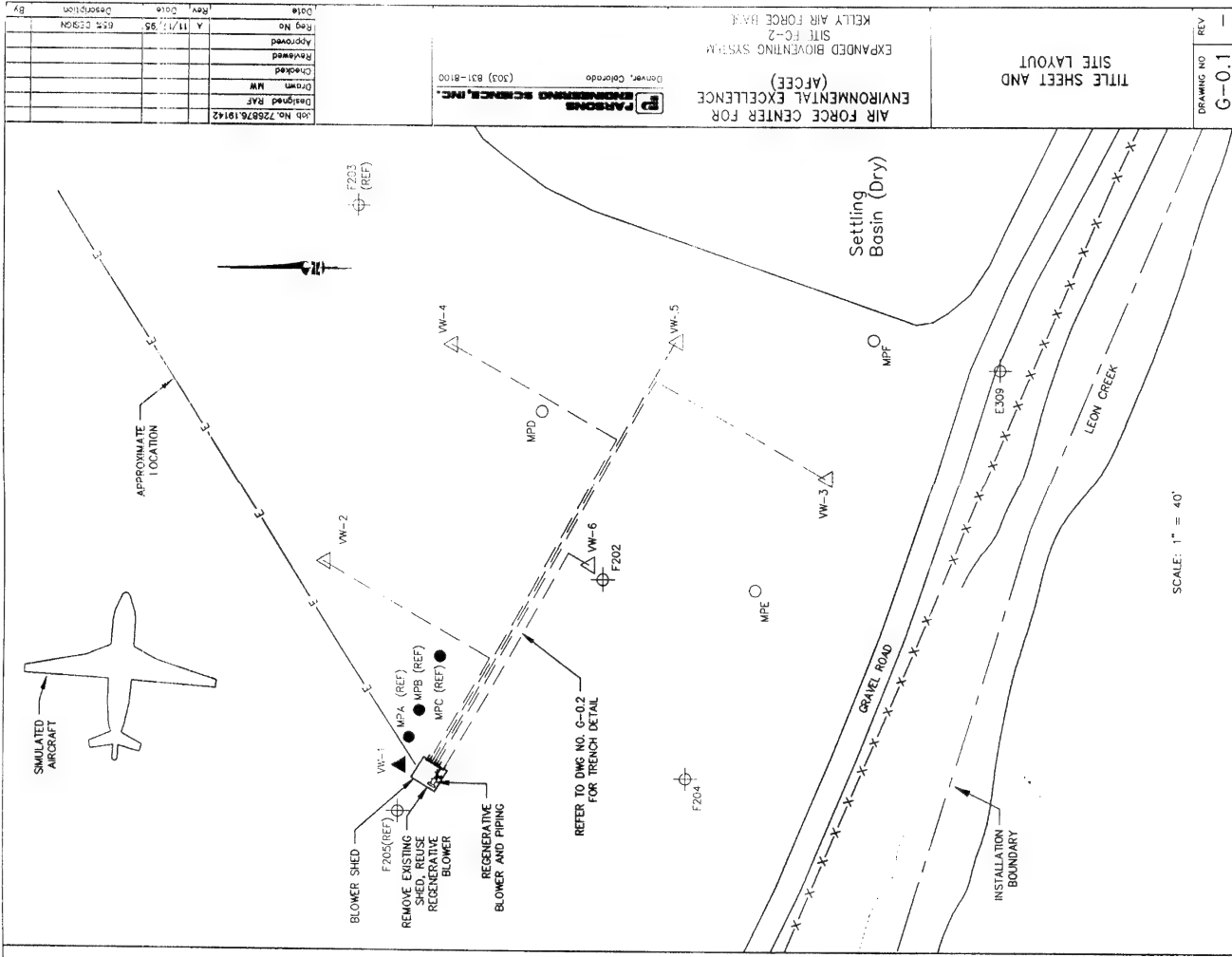
Parsons Engineering Science is under contract to assist Kelly AFB personnel in the maintenance of the bioventing system at Site FC-2 for one year. During this year, Kelly AFB personnel will be responsible for performing biweekly monitoring, and routine maintenance activities. After one year of operation, Parsons ES will perform in-situ respiration testing and soil gas sampling to assess closure options for the site, and to determine if bioventing should be continued to complete remediation of site soils. Parsons ES will request Kelly AFB personnel to shut off air injection 30 days prior to 1-year testing activities. Closure soil sampling will be conducted by Parsons ES if soil gas and respiration test data indicate that site soils are adequately remediated to attain closure.

In the event further system operation is required, performance of monitoring and maintenance operations will be the responsibility of the Air Force. If one more year of extended operation and testing is determined to be necessary, Parsons ES may be able to funded to assist Kelly AFB in the continued maintenance of the blower system and to perform another round of soil gas sampling and in-situ respiration testing after the second year of operation.

ATTACHMENT A
AS-BUILT DESIGN PACKAGE

CONSTRUCTION DRAWINGS FOR
EXPANDED BIOVENTING SYSTEM
SITE FC-2
KELLY AIR FORCE BASE
PREPARED FOR
AFCEE
NOVEMBER 1995

DRAWING NO	DRAWING NAME
G-0.1	TITLE SHEET AND SITE LAYOUT
G-0.2	LEGEND AND STANDARD TRENCH DETAIL
G-0.3	VENT WELL AND MONITORING POINT STANDARD DETAILS
G-0.4	BLOWER P & ID
G-0.5	BLOWER PIPING LAYOUT DETAIL
G-0.6	BLOWER SHED BASE AND SUPPORT DETAIL
G-0.7	BLOWER SHED FIELD INSTALLATION DETAIL AND BLOWER SHED CONSTRUCTION DETAIL



ABBREVIATIONS

AIJ	AIR INJECTION	CBM	CENTER BACK MOUNT
APPROX	APPROXIMATE	CLR	CLEAR
ASTM	AMERICAN SOCIETY OF TESTING AND MATERIALS	DIA	DIAMETER
&	AND	EB	EXPLORATORY BORING
AT	AT	ECC	ECCENTRIC
EW	EACH WAY	FOT	FLAT ON TOP
FPT	FEMALE PIPE THREAD	FT	FOOT
FT	FOOT	FT	FOOT
GALV	GALVANIZED STEEL	le	FOR LOWER MOUNT
LM	LOWER MOUNT	MAX	MAXIMUM
MIN	MINIMUM	MP	MONITORING POINT
MPT	MALE PIPE THREAD	MPT	MONITORING POINT
NO. #	NUMBER	NTS	NOT TO SCALE
OC	ON CENTER	OD	OUTSIDE DIAMETER
OD	OUTSIDE DIAMETER	PVC	POLYVINYL CHLORIDE
PW	PROPOSED WELL	RED	REDUCER
REF	REFERENCE	SCH	SCHEDULE
S	SOCKET	SPVC	SLOTTED POLYVINYL CHLORIDE
TYP	TYPICAL	VW	VENT WELL
W/	WITH	W/	WITH
WN	WELD NECK	WN	WELD NECK

SYMBOLS

F-204	EXISTING MONITORING WELL
MPC	EXISTING BIOVENTING MONITORING POINT
MPD	PROPOSED BIOVENTING MONITORING POINT
VW-1	EXISTING VENT WELL
VW-2	PROPOSED VENT WELL
---	PROPOSED HEADER PIPE TO VENT WELL
—E—E—	BURIED ELECTRICAL CONDUIT

SECTION DESIGNATION	SECTION NAME	SCALE
A	SECTION CUT	SCALE: NTS
X	DRAWING OF ORIGIN	SCALE

DETAIL NO	DETAIL NAME	SCALE
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X	DRAWING OF ORIGIN	SCALE

MATERIAL LEGEND

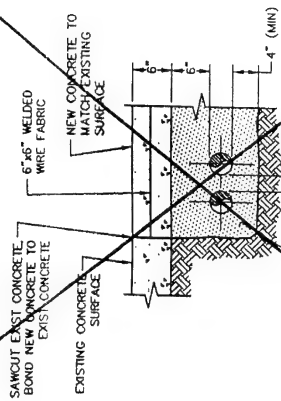
	ASPHALT
	BENTONITE
	BENTONITE/CEMENT GROUT (EXISTING)
	BENTONITE PELLETS
	BUILDING (EXISTING)
	COMPACTED BACKFILL
	COMPACTED BASE STONE
	CONCRETE
	PEA GRAVEL
	SAND
	UNDISTURBED SOIL

PIPE MATERIAL

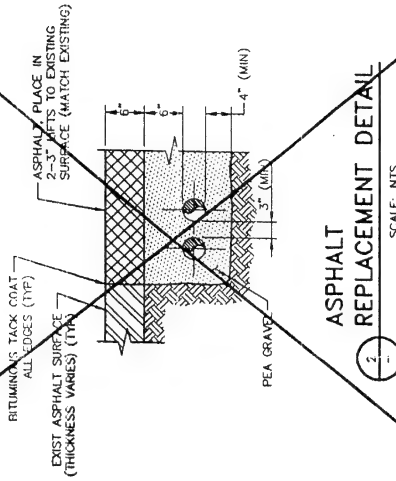
CS	CARBON STEEL
GALV	GALVANIZED STEEL
PVC	POLYVINYL CHLORIDE
SPVC	SLOTTED POLYVINYL CHLORIDE

PIPE SERVICE

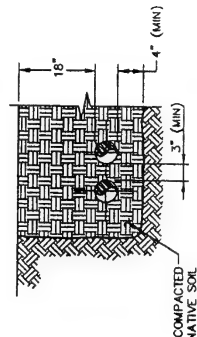
AIJ	AIR INJECTION
BIV	BIOVENTING
DR	DRAIN



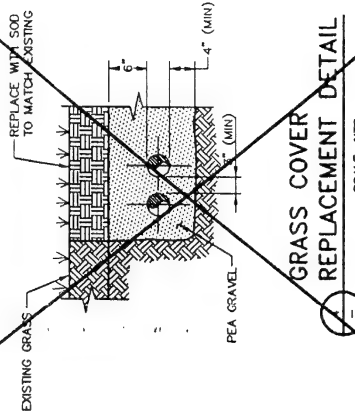
CONCRETE REPLACEMENT DETAIL 1
SCALE: NTS



ASPHALT REPLACEMENT DETAIL 2
SCALE: NTS



SOIL COVER REPLACEMENT DETAIL 3
SCALE: NTS



GRASS COVER REPLACEMENT DETAIL
SCALE: NTS

AIR FORCE CENTER FOR
ENVIRONMENTAL EXCELLENCE
(AFCEE)

EXPANDED BIOVENTING SYSTEM
SITE FC-2
KELLY AIR FORCE BASE

PARSONS
ENGINEERING AND
SCIENCE, INC.
Denver, Colorado
(303) 831-8100

Job No.	22887818142
Design	RAF
Drawn	YIM
Checked	RAF 11/25/95
Approved	RAF 11/25/95
Scale	AS
Date	11/17/95
Design	65% DESIGN

LEGEND AND
STANDARD TRENCH DETAILS

DRAWING NO
REV
G-0.2

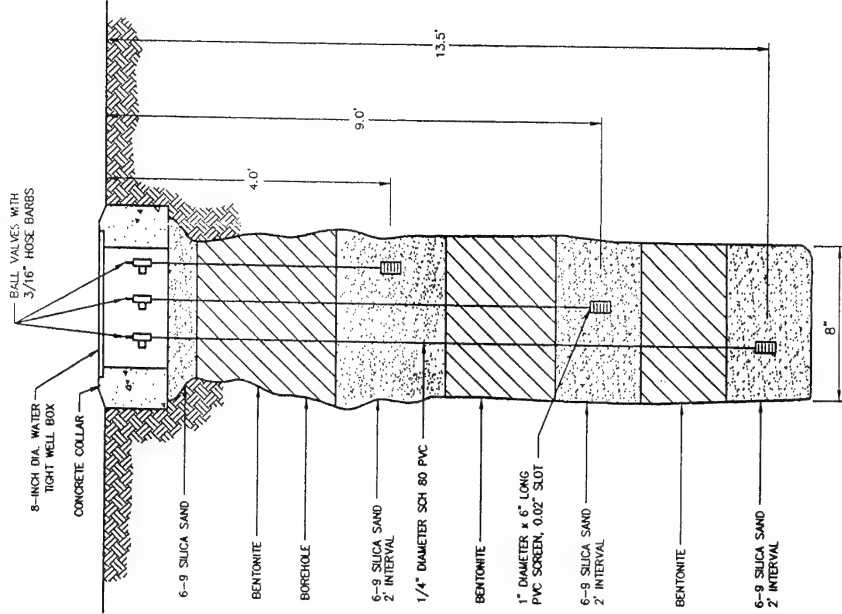
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Drawn By	LM
Checked By	11/17/05
Reviewed By	11/17/05
Approved By	11/17/05
Reg. No.	11/17/05
Date	11/17/05
Rev.	055 0550N
Drawn By	055 0550N
By	

PARSONS
ENGINEERING SCIENCE, INC.
Denver, Colorado
(303) 831-8100

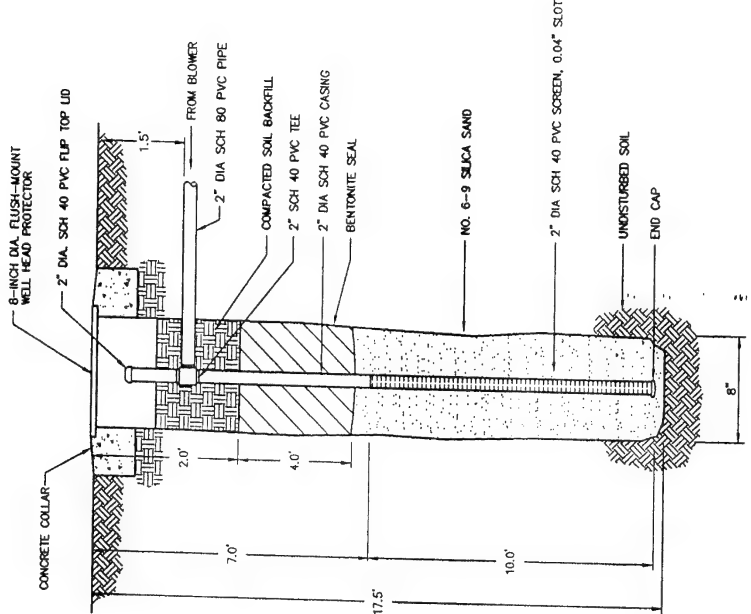
AIR FORCE CENTER FOR
ENVIRONMENTAL EXCELLENCE
(AFCEE)
EXPANDED BIOVENTING SYSTEM
SITE FC-2
KELLY AIR FORCE BASE

VENT WELL AND
MONITORING POINT
STANDARD DETAILS

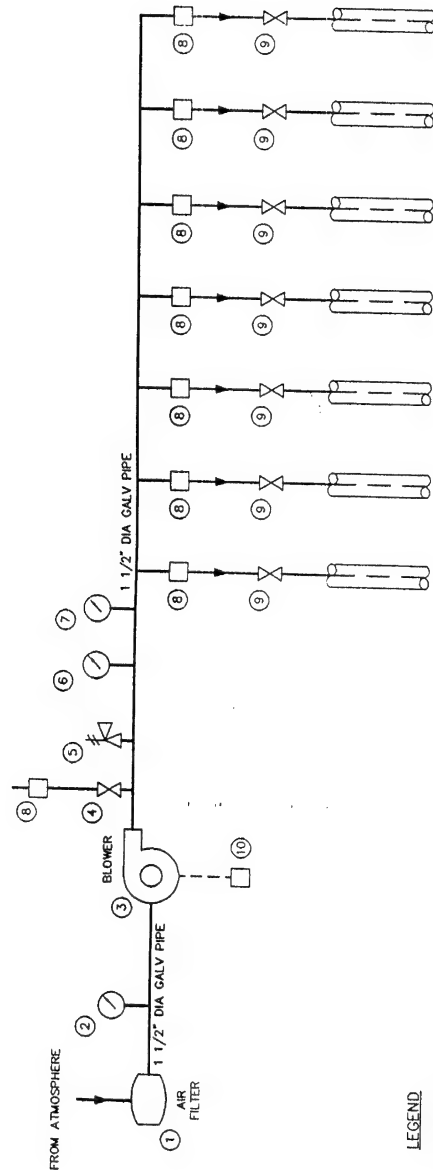
DRAWING NO.
G-0.3



2 MONITORING POINT (MP) DETAIL
SCALE: NTS



1 VENT WELL (VW) DETAIL
SCALE: NTS



LEGEND

- 1 INLET AIR FILTER - SOLBERG F-30P-150, REPLACEMENT ELEMENT 30P
- 2 VACUUM GAUGE - WKA 611.10, 2 1/2" DIA., 0-30" H₂O, 1/4" NPT, LM (Part No. 9852344)
- 3 BLOWER - GAST® 2.5HP RS1250-60, 130 CFM AT 15" H₂O PRESSURE (EXISTING)
- 4 MANUAL PRESSURE RELIEF (BLEED) VALVE - 1 1/2" GATE
- 5 AUTOMATIC PRESSURE RELIEF VALVE - CAST AG258, SET TO RELEASE AT 40" H₂O PRESSURE
- 6 TEMPERATURE GAUGE - ASHROFT, 0-250°F, 1/2" NPT, CBM (Part No. 21066 FROM GRUNGER)
- 7 PRESSURE GAUGE - WKA 611.10, 2 1/2" DIA., 0-100" H₂O, 1/4" NPT, CBM (Part No. 9851810)
- 8 FLOW MEASURING PORT FITTED WITH PLUG (1/4" x 1/8" NPT BRASS REDUCING BUSHING, 1/8" NPT BRASS PLUG)
- 9 FLOW CONTROL VALVE - 1 1/2" GATE
- 10 STARTER (EXISTING)

1 BLOWER PIPING AND INSTRUMENTATION DIAGRAM

SCALE: NTS

Job No. 22878.19142	Drawn RAN	Checked 11/17/96	Rev. 11/17/96	55% DESIGN
Approved	11/17/96	11/17/96	11/17/96	11/17/96
11/17/96	11/17/96	11/17/96	11/17/96	11/17/96
11/17/96	11/17/96	11/17/96	11/17/96	11/17/96
11/17/96	11/17/96	11/17/96	11/17/96	11/17/96

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado
(303) 831-8100

AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)
EXPANDED BIOVENTING SYSTEM
SITE FC-2
KELLY AIR FORCE BASE

BLOWER P & ID

DRAWING NO.	REV.
G-0.4	-

11/28/05 at 14.45

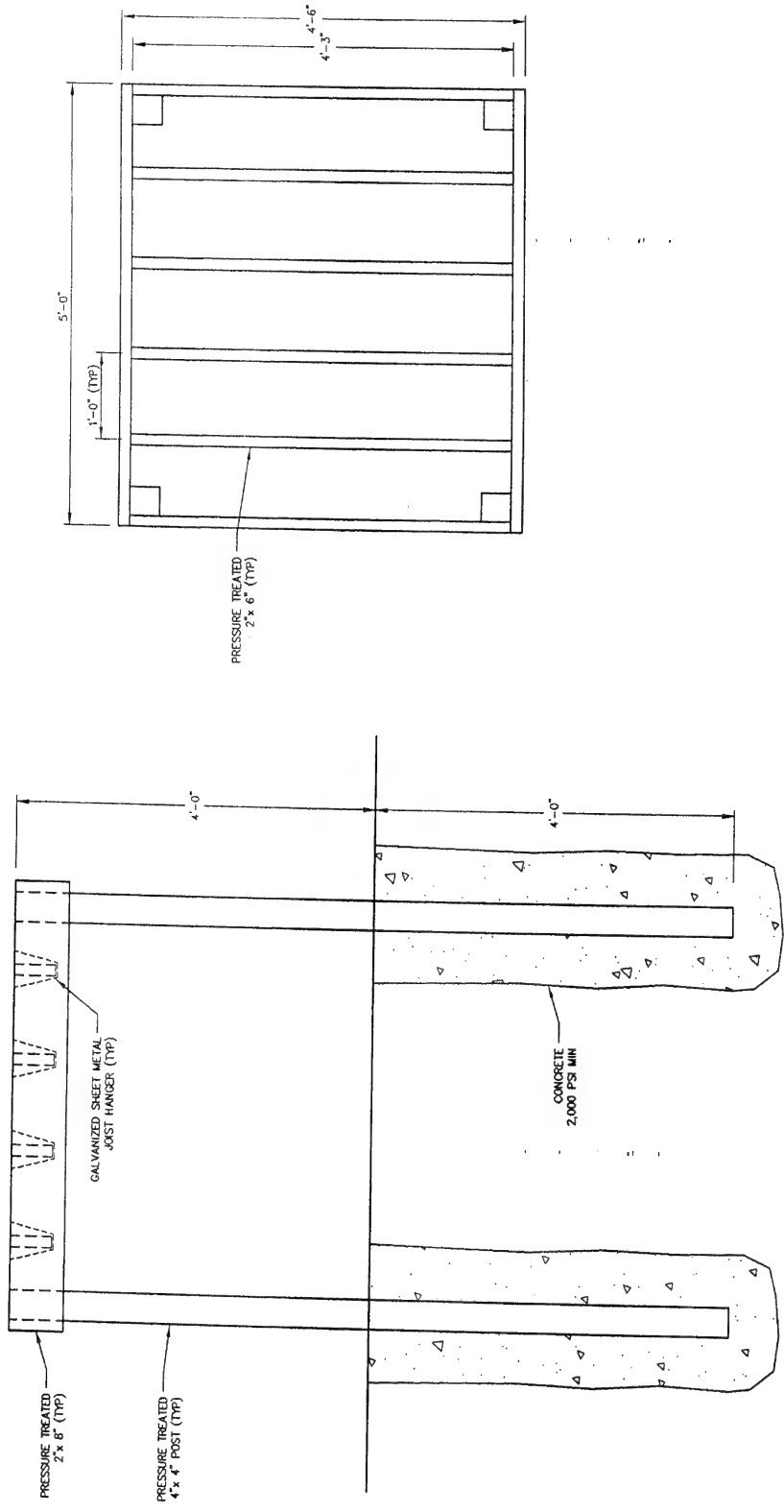
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Drawn MAF		
Checked 11/17/95		
Reviewed 11/17/95		
Approved 11/17/95		
Reg. No. A	11/17/95	65% DESIGN
Rev. 001A		04/03/2004
Date		29

PARSONS
ENGINEERING SCIENCE, INC.
Denver, Colorado
(303) 631-8100

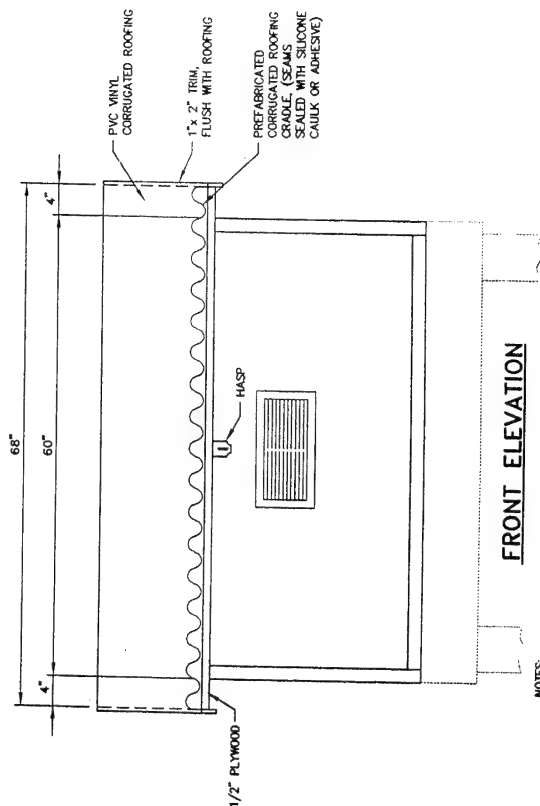
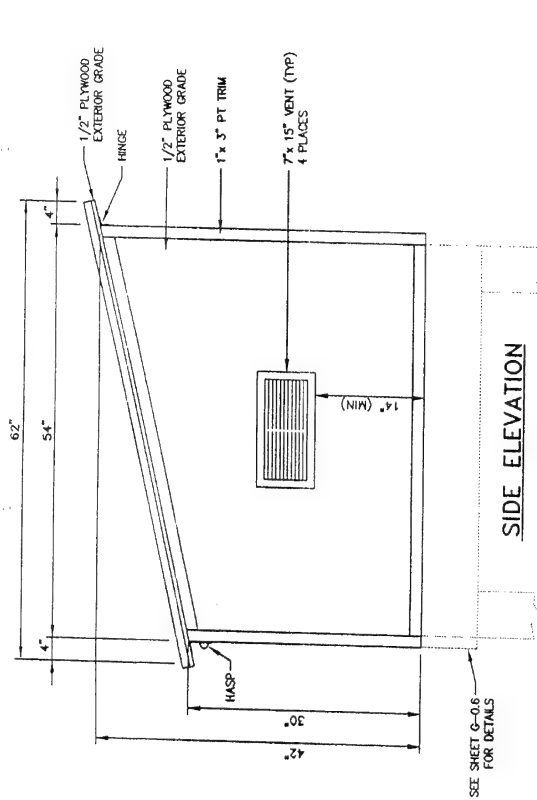
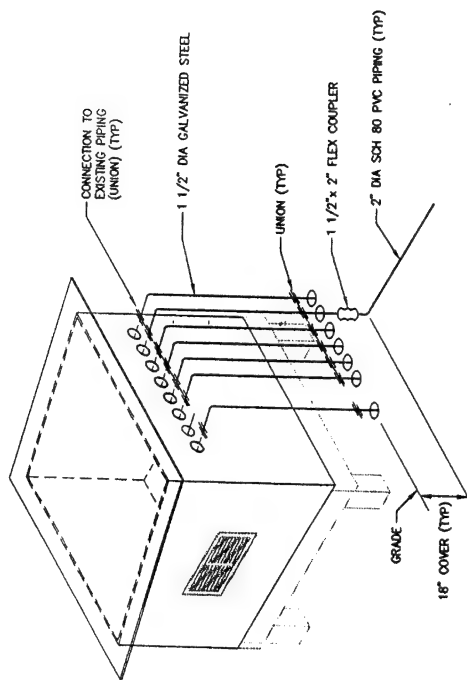
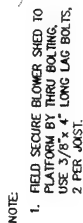
AIR FORCE CENTER FOR
ENVIRONMENTAL EXCELLENCE
(AFCEE)
EXPANDED BIOVENTING SYSTEM
SITE FC-2
KELLY AIR FORCE BASE

BLOWER PIPING
LAYOUT DETAIL

9-0.6
DRAWING NO
REV



1 BLOWER SHED BASE AND SUPPORT DETAIL
3/4" = 1'-0"



BLOWER SHED CONSTRUCTION DETAIL

DRAWING NO	REV
G-0.7	-

BLOWER SHED FIELD
INSTALLATION DETAIL
AND BLOWER SHED
CONSTRUCTION DETAILS

PARSONS ENGINEERING AND SCIENCE, INC.
Denver, Colorado (303) 831-8100

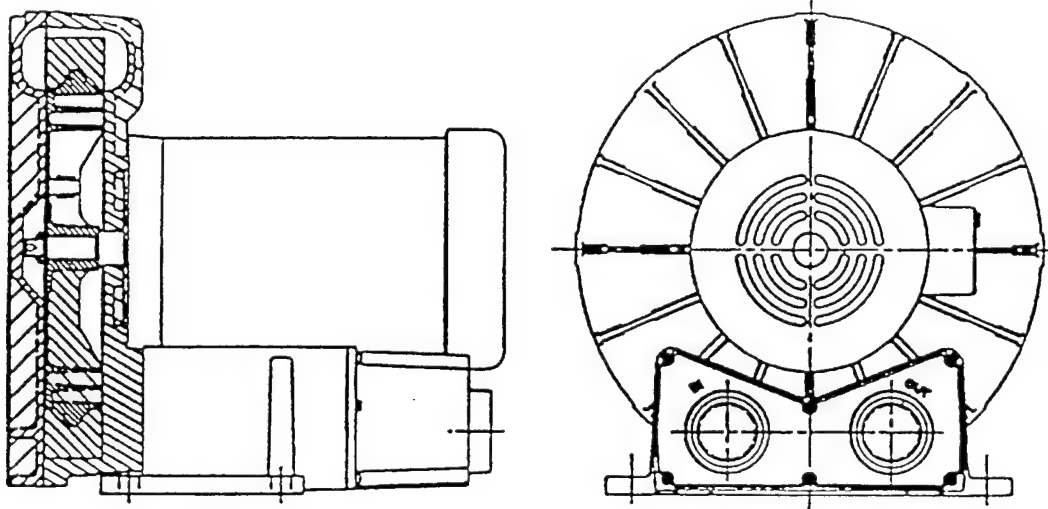
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	Approved	
	Rev	11/17/85
	Date	
	Design	85% 051010

ATTACHMENT B
BLOWER SPECIFICATIONS
AND INFORMATION



Post Office Box 97
Benton Harbor, Michigan 49023-0097
Ph: 616/926-6171
Fax: 616/925-8288

Maintenance Instructions for Gast Standard Regenerative Blowers



For original equipment manufacturers
special models, consult your local distributor

Gast Rebuilding Centers

Gast Mfg. Corp.
2550 Meadowbrook Rd.
Benton Harbor MI. 49022
Ph: 616/926-6171
Fax: 616/925-8288

Gast Mfg Corp.
505 Washington Avenue
Carlstadt, N. J. 07072
Ph: 201/933-8484
Fax: 201/933-5545

Brenner Fiedler, & Assoc.
13824 Bentley Place
Cerritos, CA. 90701
Ph: 213/404-2721
Fax: 213/404-7975

Wainbee, Limited
121 City View Drive
Toronto, Ont. Canada M9W 5A9
Ph: 416/243-1900
Fax: 416/243-2336

Wainbee, Limited
215 Brunswick Drive
Pointe Claire, P.Q. Canada H9R 4R7
Ph: 514/697-8810
Fax: 514/697-3070

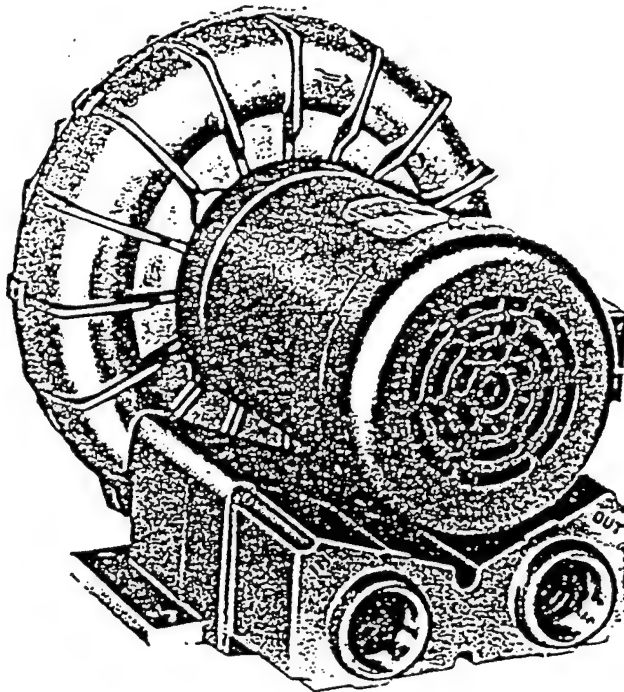
Gast Mfg. Co. Limited.
Halifax Rd, Cressex Estate
High Wycombe, Bucks HP12 3SN
Ph: 44 494 523571
Fax: 44 494 436588

Japan Machinery Co. Ltd.
Central PO Box 1451
Tokyo 100-91 Japan
Ph: 813/3573-5421
Fax: 813/3571-7865

Oilless Regenerative Blowers, Motor Mounted to 160 cfm



REGENAIR® R5 Series



MODEL R5325A-2

65" H₂O MAX. PRESSURE, 160 CFM OPEN FLOW

PRODUCT FEATURES

- Oilless operation
- TEFC motor mounted
- Can be mounted in any plane
- Rugged construction/low maintenance

COMMON MOTOR OPTIONS

- 115/208-230V, 60 Hz, single phase
- 208-230/460V, 60 Hz; 190-220/380-415V, 50 Hz, three phase
- 575V, 60 Hz, three phase

RECOMMENDED ACCESSORIES

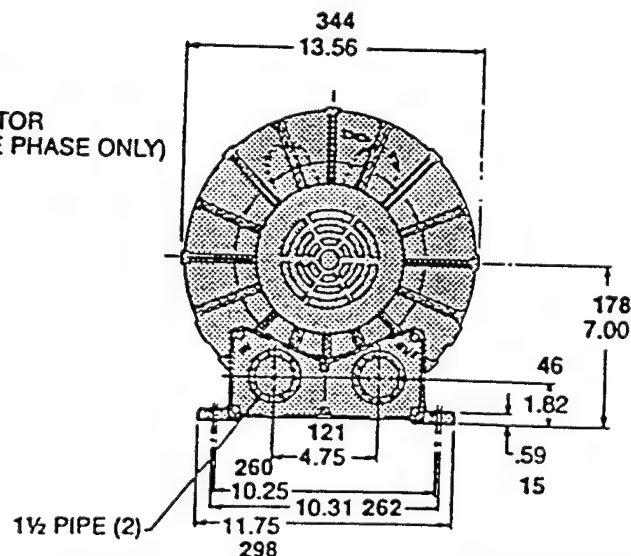
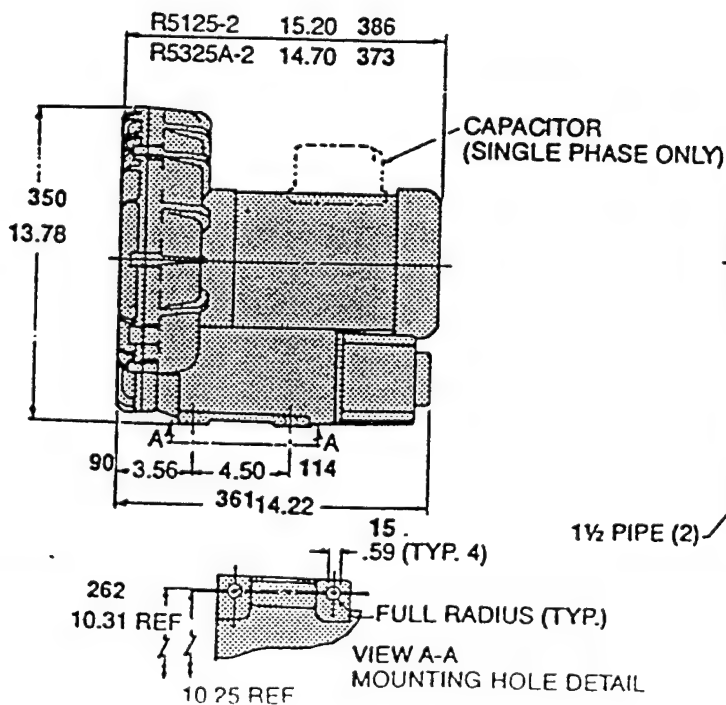
- Pressure gauge AE133
- Filter AG338
- Muffler AJ121D
- Relief valve AG258

Various brand name motors are used on any model at the discretion of Gast Mfg. Corp.

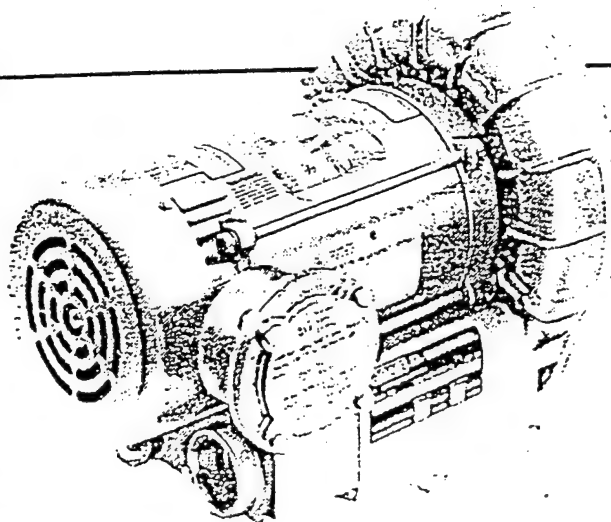
Important Notice:

Pictorial and dimensional data is subject to change without notice.

Product Dimensions Metric (mm) U.S. Imperial (inches)



R4, R5, R6P Series



MODEL R4 SERIES

48" H₂O MAX. VAC., 88 CFM OPEN FLOW

MODEL R5 SERIES

60" H₂O MAX. VAC., 145 CFM OPEN FLOW

MODEL R6P SERIES

90" H₂O MAX. VAC., 260 CFM OPEN FLOW

PRODUCT FEATURES

- Explosion-proof motors UL (class 1, group D; class 2, groups F & G)
- Sealed air stream
- Rugged construction
- Low maintenance

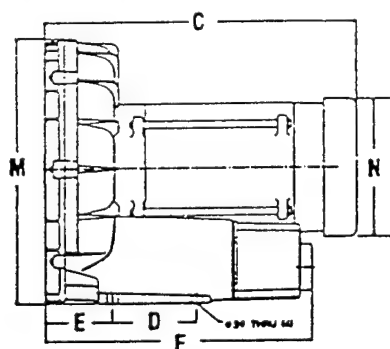
RECOMMENDED ACCESSORIES

- Inlet filter AJ151G
(Reducing filter plumbing from 2½" to 1½" is needed to accommodate filter on R4 and R5 models.)
- Relief valve AG258
- Vacuum gauge AE134

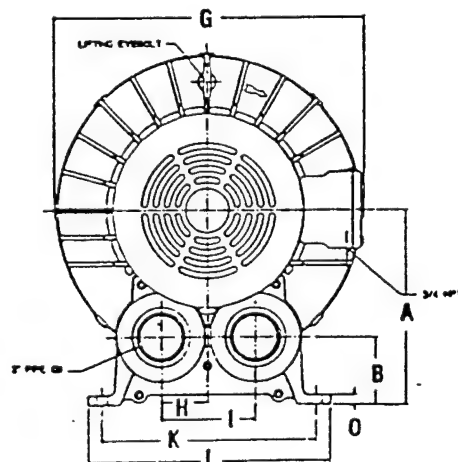
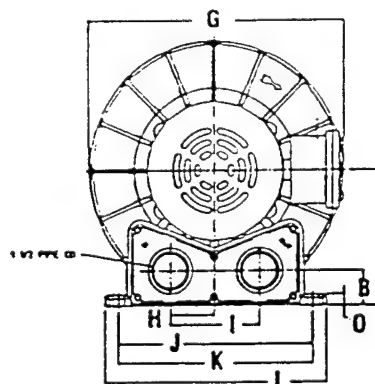
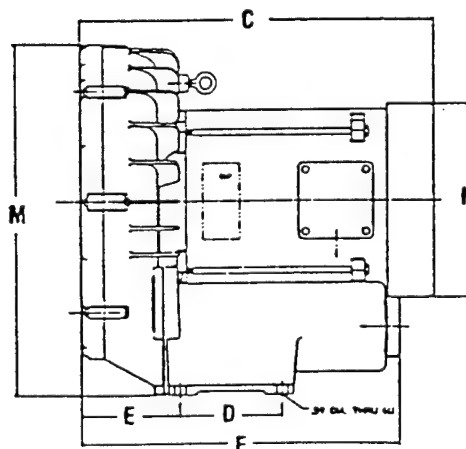
Product Dimensions Metric (mm) U.S. Imperial (Inches)

Model	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
R4110N-50	157	43	360	95	72	316	313	50	101	225	227	254	293	175	11
	6.18	1.68	14.16	3.75	2.85	12.44	12.31	1.96	3.96	8.86	8.93	10.00	11.73	6.88	.44
R4310P-50	157	43	360	95	72	316	313	50	101	225	227	254	293	175	11
	6.18	1.68	14.17	3.75	2.84	12.44	12.31	1.96	3.96	8.86	8.93	10.00	11.73	6.88	.44
R5325R-50	178	46	423	114	91	361	344	60	121	260	262	298	350	183	15
	7.00	1.82	16.66	4.50	3.58	14.22	13.56	2.38	4.75	10.25	10.31	11.75	13.78	7.19	.59
R6P355R-50	248	80	482	140	137	438	428	64	127	—	290	325	453	257	13
	9.77	3.15	18.98	5.51	5.39	17.25	16.87	2.50	5.00	—	11.42	12.80	18.21	10.12	.50

Model R4 Series
Model R5 Series



Model R6P Series

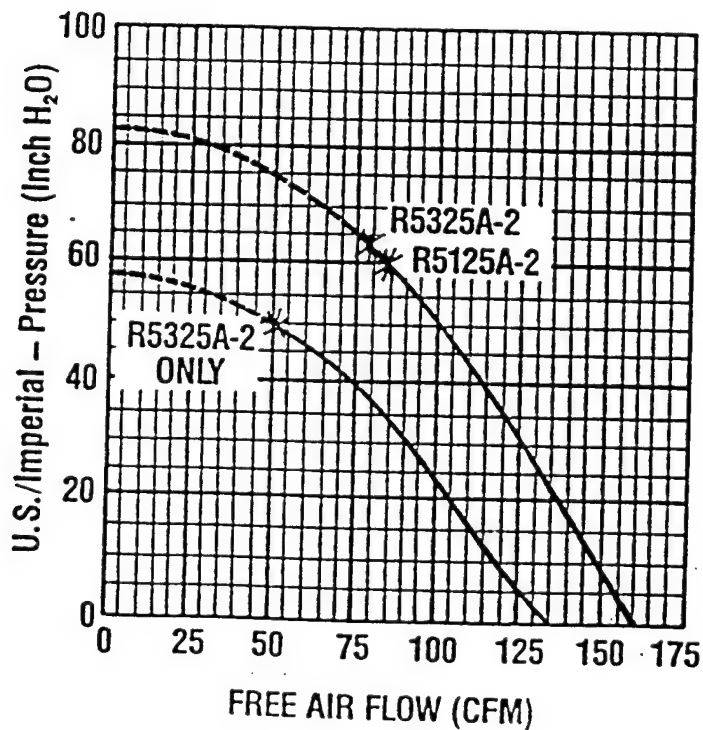
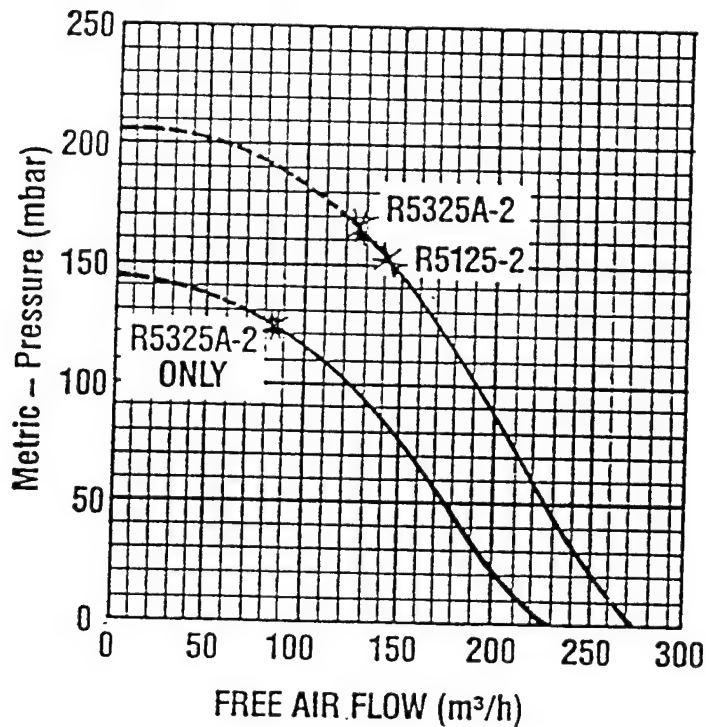


NOTE: These units with explosion-proof motors are designed specifically for qualified OEMs in the soil remediation industry. They are not intended to be applied for other uses without written acknowledgement from an authorized employee of Gast Manufacturing Corporation.

Product Specifications

Model Number	Motor Specs	Full Load Amps	HP	RPM	Max Pressure		Max Flow		Net Wt.	
					H ₂ O	mbar	cfm	m ³ /h	lbs.	kg
R5325A-2	190-220/380-415-50-3	6.6-6.7/3.3-3.5	1.35	2850	50	125	133	226	65	29,5
	208-230/460-3	6.9/3.45	2.5	3450	65	162	160	272		
R5125-2	115/208-230-60-1	22.4/12.4-11.2	2.5	3450	60	149	160	272	73	33,1

Product Performance (Metric U.S. Imperial) Black line on curve is for 60 cycle performance.
Blue line on curve is for 50 cycle performance.



*Recommended maximum duty.
---- Intermittent duty only.

All performance figures relate to stock models. A few high pressure units may be available. Consult your local distributor.

Regenair Model Number	P R E S S U R E						Maximum Pressure "H ₂ O"
	0"H ₂ O	20"H ₂ O	40"H ₂ O	60"H ₂ O	80"H ₂ O	100"H ₂ O	
R1	26	14					28
R2	42	26					38
R3105-1	52	38	14				42
R3105-12	52	36	23				55
R3305A-13	52	36	23				55
R4	90	70	50				52
R5	145	130	100				65
R6125-2	200	180					35
R6325A-2	200	180	152				40
R6335A-2	205	175	155	135			70
R6350A-2	200	180	150	130	110	80	105
R6P335A	290	250					30
R6P350A	300	260	230	200			60
R6P355A	300	260	230	200	160		90
R7100A-2	420	380	340	310	280	230	115
R6PP3110M	485	452	420	380	330		95
R6PS3110M	265	258	252	244	236	226	170

Regenair Model Number	V A C U U M					Maximum Vacuum "H ₂ O"
	0"H ₂ O	20"H ₂ O	40"H ₂ O	60"H ₂ O	80"H ₂ O	
R1	25	14				26
R2	40	22				34
R3105-1	50	34	9			40
R3105-12	51	34	20			50
R3305A-13	51	34	20			50
R4	82	62	39			48
R5	140	115	90	50		60
R6125-2	190	155	125			45
R6325A-2	190	155	125			45
R6335A-2	190	150	125	100		75
R6350A-2	190	180	150	100	70	90
R6P335A	270	230				37
R6P350A	280	240	210	170		70
R6P355A	280	240	210	170	100	86
R7100A-2	410	350	300	250	170	90
R6PP3110M	470	425	375	320	220	80
R6PS3110M	240	225	210	195	175	130

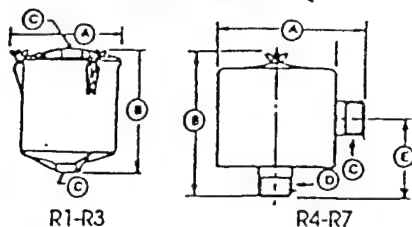
*This number indicates the maximum static pressure differential recommended (with cooling air still flowing through unit). In general, units 1hp or less can be dead headed. Check with local representative or distributor to verify which models apply.

Operation of the blower above the recommended maximum duty will cause premature failure due to the build up of heat damaging the components.

Performance data was determined under the following conditions:

- 1) Unit in a temperature stable condition.
- 2) Test conditions: Inlet air density at 0.075lbs. per cubic foot. (20°C(68°F), 29.92 in. Hg(14.7PSIA)).
- 3) Normal performance variations on the resistance curve within +/- 10% of supplied data can be expected.
- 4) Specifications subject to change without notice.
- 5) All performance at 60Hz operation.

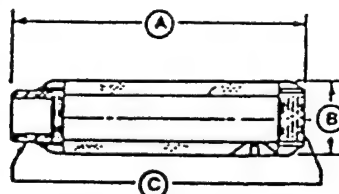
Inline Filters (for vacuum)



Model Number	R1 & R2	R3	R4, R5 & SDR4	R6P SDR5, SDR6 R6PP, R6PS	R7
Part #	AV460	AV460C	AG337	AJ151G	AJ151H
Dim A	8.25"	8.25"	11.75"	8.00"	16.25"
Dim B	8.875"	8.875"	4.75"	10.25"	27.13"
Dim C	1" FPT	1 1/4" FPT	1 1/2" MPT	2 1/2" MPT	3" MPT
Dim D	-	-	1 1/2" FPT	2 1/2" MPT	3" MPT
Dim E	-	-	2.38	5.50	18.50
Replacement Element	AV469	AV469	AG340	AJ135G	AJ135C
Micron	10	10	25	10	10

MPT = Male Pipe Thread
FPT = Female Pipe Thread

Mufflers



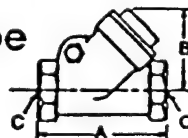
Model Number	R2	R3	R4, R5 SDR 4" & SDR5"	R6, SDR6" R6P R6PP, R6PS	R7
Part #	AJ121B	AJ121C	AJ121D	AJ121F	AJ121G
Dim. A	7.46**	7.94**	12.75**	17.05**	17.44**
Dim. B	2.38"	2.62"	3.25"	3.63"	4.25"
Dim. C	1" NPT	1 1/4" NPT	1 1/2" NPT	2" NPT	2 1/2" NPT

* For Inlet Only
** Approximately

Fittings

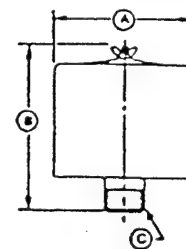
Pipe Size	1"	1 1/4"	1 1/2"	2"	2 1/2"
Tee	BA415	BA431	BA432	BA433	BA434
Common Elbow	BA220	BA244	BA230	BA247	BA248
Nipple	BA752	BA809	BA783	BA810	BA813
Plastic Male Pipe Hose Barb	AJ117A	AJ117B	-	-	-
Hose I.D.	1.25	1.25	-	-	-
Metal Male Pipe Hose Barb	AJ117D	AJ117F	AJ117C	AJ117G	AJ117H
Hose I.D.	1.00	1.25	1.50	2.50	3.00

Horizontal Swing Type Check Valve



Model Number	R1, R2	R3	R4, R5 SDR 4" & SDR5	R6, SDR6 R6P R6PP, R6PS	R7
Part #	AH326B	AH326C	AH326D	AH326F	AH326G
Dim. A	3.57	4.19	4.50	5.25	8
Dim. B	2.32	2.69	2.94	3.82	5.07
Dim. C	1" NPT	1 1/4" NPT	1 1/2" NPT	2" NPT	2 1/2" NPT

Inlet Filters (for pressure units only)



Model Number	R1 & R2	R3	R4, R5 & SDR4	R6, SDR5 SDR6, R6P R6PP, R6PS	R7
Part #	AJ126B	AJ126C	AG338	AJ126F	AJ126G
Dim A	6.00"	6.00"	10.63"	10.63"	10.00"
Dim B	4.62**	7.12**	4.81**	4.81**	13.12**
Dim C	1" MPT	1 1/4" MPT	1 1/2" FPT	2" FPT	2 1/2" MPT
Replacement Element	AJ134B	AJ134C	AG340	AG340	AJ135A
Micron	10	10	25	25	10

All are heavy duty for high amounts of particulates.
Inlet filters for REGENAIR blowers are drip-proof when mounted as shown.

Pressure-Vacuum Gauge



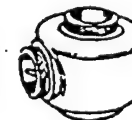
Pressure Gauge, Part #AJ496, 2 5/8" Diameter, 1/4" NPT, 0-60 Inches H₂O and 0-150 mbar

Pressure Gauge, Part #AE133A, 2 5/8" Diameter, 1/4" NPT, 0-200 Inches H₂O and 0-500 mbar

Vacuum Gauge, Part #AJ497, 2 5/8" Diameter, 1/4" NPT, 0-60 Inches H₂O and 0-150 mbar

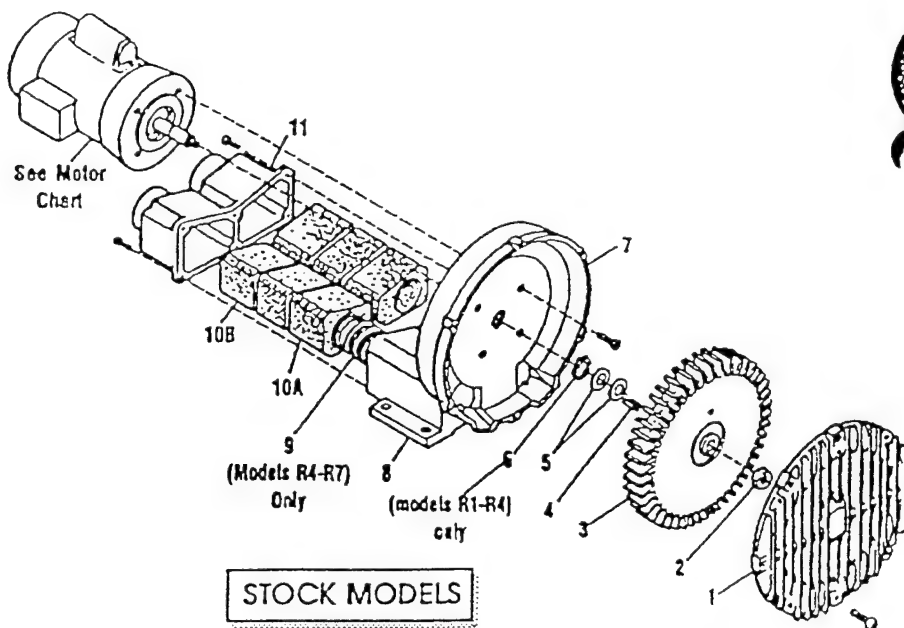
Vacuum Gauge, Part #AE134, 2 5/8", Diameter, 1/4" NPT, 0-160 Inches H₂O and 0-400 mbar

Relief Valve



Pressure/Vacuum Relief Valve, Part #AG258, 1 1/2" NPT, Adjustable 30-170 Inches H₂O. 200 CFM maximum

Silencer for Relief Valve, Part #AJ121D



STOCK MODELS

Part Name	R1	R2	R3	R4	R5	R6	R6P	R6PP/R6PS	R7
1 Cover	AJ101A	AJ101B	AJ101C	AJ101D	AJ101EQ	AJ101F	AJ101K	(2)AJ101KA	AJ101G
2 Nut	BC187	BC187	BC181	BC181	BC181	BC181	BC181	(2)BC182	BC183
3 Impeller	AJ102A	AJ102BQ	AJ102C	AJ102D	AJ102E	AJ102FR	AJ102K	(2)AJ102KA	AJ102GA
4 Square Key	AH212C	AH212	AB136A	AB136D	AB136	AB136	AB136	(2)AB136	AC628
5 Shim Spacer (s)	AJ132	AE686-3	AJ109	AJ109	AJ109	AJ116A	AJ116A	AJ116A	AJ110
6 Retaining Ring	AJ145	AJ145	AJ149	AJ149					
7 Housing	AJ103A	AJ103BQ	AJ103C	AJ103DR	AJ103E	AJ103F	AJ103K	AJ103KD	AJ103GA
8 Muffler Box					AJ104E	AJ104F			
9 Spring				AJ113DR	AJ113DQ	AJ113FQ	AJ113FQ		AJ113G
10 A Foam	(4)AJ112A	(4)AJ112B	(4)AJ112C	(4)AJ112DS	(4)AJ112ER	(6)AJ112F	(8)AJ112K		(8)AJ112GA
10 B Foam		(2)AJ112BQ	(2)AJ112CQ	(2)AJ112DR	(2)AJ112EQ				
11 Muffler Extension/ Adaptor Plate	AJ106H	AJ106BQ	AJ106CQ	AJ106DQ	AJ106EQ	AJ106FQ	AJ104K		AJ104GA
12 Kit	K396	K396							K395

MOTOR CHART

MODEL NUMBER	MOTOR NUMBER	60 HZ VOLTS	50 HZ VOLTS	PHASE
R1102	J111X	115/208-230	110/220-240	1
102C	J112X	115		1
2103	J311X	115/208-230	110/220	1
R2105	J411X	115/208-230	110/220	1
R2303A	J310	208-230/460	220/380-415	3
2303F	J313	208-230	220	3
3105-1/R3105-12	J411X	115/208-230	110/220-240	1
R3305A-1/R3305A-13	J410	208-230/460	220/380-415	3
R4110-2	J611AX	115/208-230	110/220-240	1
310A-2	J610	208-230/460	220/380-415	3
4125-2	J811X	115/208-230		1
R5325A-2	J810X	208-230/460	220/380-415	3
5125-2	J811X	115/208-230		1
325A-2	J810X	208-230/460	220/380-415	3
R6335A-2	J910X	208-230/460	220/380-415	3
R6150J-2	J1013	230		1
360A-2	J1010	208-230/460	220/380-415	3
P335A	J910X	208-230/460	220/380-415	3
R6P350A	J1010	208-230/460	220/380-415	3
P355A	J1110A	208-230/460	220/380-415	3
100A-2	J1210B	208-230/460	220/380-415	3
R6PP/R6PS3110M	JD1100	208-230/460	220/380-415	3

* No lubrication needed at start up.
Bearings lubricated at factory.

* Motor is equipped with alemite fitting.
Clean tip of fitting and apply grease gun.
Use 1 to 2 strokes of high quality ball
bearing grease.

Consistency	Type	Typical Grease
Medium	Lithium	Shell Dolum R

Hours of service per year

Suggested Relube Interval

5,000

3 years

Continual Normal Application

1 year

Seasonal service motor
idle for 6 months or more

1 year beginning
of season
6 months

Continuous-high ambients,
dirty or moist applications.



Post Office Box 97
Benton Harbor, MI. 49023-0097
Ph: 616/926-6171
Fax: 616/925-8288

F2-205/8/92
AK811 Rev. E

INSTALLATION AND OPERATING INSTRUCTIONS FOR GAST HAZARDOUS DUTY REGENAIR BLOWERS

This instruction applies to the following models ONLY: R3105N-50, R4110N-50, R4310P-50, R4P115N-50, R5125Q-50, R5325R-50, R6130Q-50, R6P155Q-50, R6350R-50, R6P355R-50 and R7100R-50.

Gast Authorized Service Facilities are Located in the locations listed below

Gast Manufacturing Corporation
505 Washington Avenue
Carlstadt, N. J. 07072
Ph: 201/933-8484
Fax: 201/933-5545

Gast Manufacturing Corporation
2550 Meadowbrook Road
Benton Harbor, MI. 49022
Ph: 616/926-6171
Fax: 616/925-8288

Renner Fiedler & Associates
3824 Bentley Place
Ft. Collins, CO. 90701
Ph: 213/404-2721
Fax: 800/843-5558
Fax: 213/404-7975

Wainbee Limited
215 Brunswick Blvd.
Pointe Claire, Quebec
Canada H9R 4R7
Ph: 514/697-8810
Fax: 514/697-3070

Wainbee Limited
5789 Coopers Ave.
Mississauga, Ontario
Canada L4Z 3S6
Ph: 416/243-1900
Fax: 416/243-2336

Japan Machinery
Central PO Box 1451
Toyko 100-91, Japan
Ph: 813 3573-5421
Fax: 813 3571-7896

Gast Manufacturing Co. Ltd.
Halifax Road, Cressex Estate
High Wycombe, Bucks HP12 3SN
England
Ph: 44 494 523571
Fax: 44 494 436588

Safety

- ⚠ This is the safety alert symbol. When you see this symbol, personal injury is possible. The degree of injury is shown by the following signal words:
- ⚠ **DANGER:** Severe injury or death will occur if hazard is ignored.
 - ⚠ **WARNING:** Severe injury or death can occur if hazard is ignored.
 - ⚠ **CAUTION:** Minor injury or property damage can occur if hazard is ignored.
- Review the following information carefully before operating.

General Information

- ⚠ **DANGER:** Do not pump flammable or explosive gases or operate in an atmosphere containing them. Ambient temperature for normal operation should not exceed 40 degrees C (105 degrees F). For higher ambient operation, consult the factory. Blower performance is reduced by the lower atmospheric pressure of high altitudes. If it applies to this unit, consult a Gast distributor or the factory for details.

Installation

- ⚠ **WARNING:** Electric Shock can result from bad wiring. Wiring must conform to all required safety codes and be installed by a qualified person.

Grounding is required.

The Gast Regenair blower can be installed in any position. The flow of cooling air over the blower and motor must not be blocked.

PLUMBING - The threaded pipe ports are designed as connection ports only and will not support the plumbing. Be sure to use the same or larger size pipe and fittings to prevent air flow restriction and over-heating of the blower. When installing plumbing, be sure to use a small amount of pipe thread lubricant. This protects the threads in the aluminum blower housing. Dirt and chips, often found in new plumbing, should not be allowed to enter the blower.

NOISE - To reduce noise and vibration, the unit should be mounted on a solid surface that will not increase sound. The use of shock mounts or vibration isolation material is recommended. If needed, inlet or discharge noise can be reduced by attaching muffler assemblies (see accessories).

ROTATION - The Gast Regenair blower should only rotate clockwise as viewed from the electric motor side. This is marked with an arrow in the casting. Proper rotation can be confirmed by checking air flow at the IN and OUT ports. On blowers powered by a three phase motor, rotation is reversed by changing any two of the three power wires.

Operation

- ⚠ **WARNING:** Solid or liquid material exiting the blower or piping can cause eye damage or skin cuts. Keep away from air stream.
- ⚠ **CAUTION:** Attach blower to solid surface before starting. Prevent injury or damage from unit movement.

Air containing solid particles or liquid must pass through a filter before entering the blower (see accessories list for filter suggestions). Blowers must have mufflers, filters, other accessories and all piping attached before starting. Any foreign material passing through the blower may cause internal damage.

- ⚠ **CAUTION:** Outlet piping can burn skin. Guard or limit access.

Mark "CAUTION Hot surface. Can cause burns."

Air temperature increases when passing through the blower. When run at duties above 50 in. H₂O, metal pipe may be required for hot exhaust air.

The blower must not be operated above the limits for continuous duty. "Standard" R1, R2, R3 and R4 can operate continuously with not air flowing through the blower. Other units can only be run at the rating shown on the model number label. Do not close off inlet (for vacuum) or exhaust (for pressure) to reduce extra air flow. This could cause added heat and motor load.

ACCESSORIES - Gast pressure gauges AJ496 or AE133 and vacuum gauges AJ497 or AE134 show blower duty. The Gast pressure/vacuum relief valve, AG258, will limit the operating duty by admitting or relieving air. It also allows full flow through the blower when the relief valve closes.

Servicing

- ⚠ **WARNING:** Disconnect electric power before servicing. Be sure rotating parts have stopped. Electric shock or severe cuts can result. Inlet and exhaust filters need occasional cleaning or replacement of the elements. Failure to do so will result in more pressure drop, reduced air flow and hotter operation. The outside of the unit requires cleaning of dust and dirt. The inside of the blower also may need cleaning to remove material coating the impeller and housing. If not done, the buildup can cause vibration, hotter operation and reduced flow. Noise absorbing foam in the mufflers may need replacement.
- KEEP THIS INFORMATION WITH THE BLOWER. REFER TO IT FOR SAFE INSTALLATION, OPERATION OR SERVICE.

TROUBLESHOOTING		
Symptom	Possible Diagnosis	Possible Remedy
Excess Vibration	Impeller damaged by foreign material Impeller contaminated by foreign material	Replace Impeller Clean Impeller, install adequate filtration
Abnormal sound	Motor bearing failed Impeller rubbing against cover or housing	Replace bearings Repair Blower, check clearances
Increase in sound	Foreign material can coat or destroy muffler foam	Replace foam muffler elements, trap or filter foreign material
Blown fuse	Electrical wiring problem	Have qualified person check fuse capacity and wiring
Unit very hot	Running at too high a pressure or vacuum	Install a relief valve

SAFETY

This is the safety alert symbol. When you see this symbol personal injury is possible. The degree of injury is shown by the following signal words:

ANGER Severe injury or death will occur if hazard is ignored.

WARNING Severe injury or death can occur if hazard is ignored.

CAUTION Minor injury or property damage can occur if hazard is ignored.

Review the following information carefully before operating.

GENERAL INFORMATION

This instruction applies to the following models ONLY:

R3105N-50, R4110N-50, R4310P-50, R4P115N-50,

R5125Q-50, R5325R-50, R6130Q-50, R6P155Q-50,

R6350R-50, R6P355R-50 and R7100R-50. These blowers

are intended for use in Soil Vapor Extraction Systems.

The blowers are sealed at the factory for very low leakage.

They are powered with a U.L. listed electric motor Class

Div. 1 Group D motors for Hazardous Duty locations.

Ambient temperature for normal full load operation

should not exceed 40° C (105° F). For higher ambient

operation, contact the factory.

Gast Manufacturing Corporation may offer general application guidance; however, suitability of the particular blower and/or accessories is ultimately the responsibility of the user, not the manufacturer of the blower.

INSTALLATION

DANGER Models R5325R-50, R6130Q-50, R6350R-50,

R5125Q-50, R6P155Q-50, R6P355R-50 AND R7100R-50

Use Pilot Duty Thermal Overload Protection. Connect-

ing this protection to the proper control circuitry is

mandated by UL674 and NEC501. Failure to do so could/

may result in a EXPLOSION. See pages 3 and 4 for

recommended wiring schematic for these models.

WARNING Electric shock can result from bad wiring. A qualified person must install all wiring, conforming to all required safety codes. Grounding is necessary.

WARNING This blower is intended for use on soil vapor extraction equipment. Any other use must be approved in writing by Gast Manufacturing, Corp. Install this blower in any mounting position. Do not block the flow of cooling air over the blower and motor.

PLUMBING - Use the threaded pipe ports for connection only. They will not support the plumbing. Be sure to use the same or larger size pipe to prevent air flow restriction and overheating of the blower. When installing fittings, be sure to use pipe thread sealant. This protects the threads in the blower housing and prevents leakage. Dirt and chips are often found in new plumbing. Do not allow them to enter the blower.

NOISE - Mount the unit on a solid surface that will not increase the sound. This will reduce noise and vibration. We suggest the use of shock mounts or vibration isolation material for mounting.

ROTATION - The Gast Regenair Blower should only rotate clockwise as viewed from the electric motor side. The casting has an arrow showing the correct direction. Confirm the proper rotation by checking air flow at the IN and OUT ports. If needed reverse rotation of three phase motors by changing the position of any two of the power line wires.

OPERATION

WARNING Solid or liquid material exiting the blower or piping can cause eye damage or skin cuts. Keep away from air stream.

WARNING - Gast Manufacturing Corporation will not knowingly specify, design or build any blower for installation in a hazardous, combustible or explosive location without a motor conforming to the proper NEMA or U. L. standards. Blowers with standard TEFC motors should never be utilized for soil vapor extraction applications or where local state and/or Federal codes specify the use of explosion-proof motors (as defined by the National Electric Code, Articles 100,500 c1990).

CAUTION Attach blower to solid surface before starting to prevent injury or damage from unit movement. Air containing solid particles or liquid must pass through a filter before entering the blower. Blowers must have filters, other accessories and all piping attached before starting. Any foreign material passing through the blower may cause internal damage to the blower.

CAUTION Outlet piping can burn skin. Guard or limit access. Mark "CAUTION Hot Surface. Can Cause Burns". Air temperature increases when passing through the blower. When run at duties above 50 in. H₂O, metal pipe may be required for hot exhaust air. The blower must not be operated above the limits for continuous duty. Only models R3105N-50, R4110N-50 and R4310P-50 can be operated continuously with no air flowing through the blower. Other units can only be run at the rating shown on the model number label. Do not Close off inlet (for vacuum) to reduce extra air flow. This will cause added heat and motor load. Blower exhaust air in excess of 230°F indicates operation in excess of rating which can cause the blower to fail.

ACCESSORIES - Gast pressure gauge AJ496 and vacuum gauges AJ497 or AE134 show blower duty. The Gast pressure/vacuum relief valve, AG258, will limit the operating duty by admitting or relieving air. It also allows full flow through the blower when the relief valve closes.

ATTACHMENT C
BLOWER SYSTEM
DATA COLLECTION SHEET

Blower Injection System Data Collection Sheet

[illegible]

* Gauge is located between the air filter and the blower.

** Same as ambient temperature.

*** Gauge is located on the outlet piping between the blower and the vent well.

ATTACHMENT D

AIR EMISSIONS SURVEY

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SECTION 1 INTRODUCTION

This document has been prepared to address potential air quality impacts from the bioventing project at the Fire Training Area (Site FC-2) located at Kelly Air Force Base (AFB), Texas. A site map of the Kelly AFB property showing the location of Kelly AFB boundaries are shown on Figure 1.

Bioventing is the forced injection of fresh air, or withdrawal of soil gas, to enhance the supply of oxygen for *in situ* bioremediation. At Site FC-2, one pressure air injection blower unit is used to inject air into the soil, thereby supplying fresh atmospheric air (with approximately 20.8 percent oxygen) to contaminated soils. Once oxygen is provided to the subsurface, existing bacteria aerobically break down fuel residuals. Aerobic biodegradation is much more efficient than anaerobic biodegradation which occurs in soils when the soils are oxygen depleted. Currently, soil gas is not withdrawn from the soil.

The Texas Clean Air Act requires permitting of any emitter of pollutants to the atmosphere. The Act is implemented through 30 TAC Chapter 116, "Control of Air Pollutants By Permits for New Construction or Modification". Bioventing systems provide oxygen to microorganisms within soils, which if soil gas is removed to accomplish the oxygenation of contaminated soils, could result in the emission of VOC. Generally, most soil gas removal systems involve very low air pollution emissions rates allowing them to be exempted, as outlined in 30 TAC 116.211, under Standard Exemption 68. Standard Exemption 68 incorporates portions of Standard Exemptions No. 80, 88, and 118.

Standard Exemption 68 is applicable for "Equipment used to reclaim or destroy chemicals removed from contaminated materials for the purpose of a remedial action". Its provisions allow air emissions of total petroleum hydrocarbon (TPH) of one pound per hour, with or without abatement devices. An emissions limit formula in Standard Exemption 118, Section (c), is used to determine maximum allowable emissions rates for chemicals other than petroleum fuels. The exemption only applies to on-site remediation. Part 68(e) provides technical conditions to be met when abatement is required to meet the specific chemical emission limit.

Site FC-2 bioventing project currently injects air, diffusing into the soil matrix, for the enrichment of oxygen. Because the current Site FC-2 bioventing system has little or no potential to emit air pollutants and is not a point source, a permit or standard exemption is not required. If the Site FC-2 bioventing system were to remove soil gas, by reversing the air flow of the current system, and emit air pollutants to the atmosphere a standard

exemption or permit would be required. The following is a description of the current Site FC-2 bioventing system and background information. Also included is a discussion of the potential air emissions of the bioventing system if soil gas is removed from the contaminated soils.



FIGURE 1

SITE LOCATION MAP

KELLY AIR FORCE BASE
SAN ANTONIO, TEXAS

TERRELL WELLS, TEX. SAN ANTONIO WEST. TEX.

N2915-W9830/7.5

N2922.5-W9830/7.5

1967

PHOTOREVISED 1973

AMS 6242 I NE-SERIES V882

1967

PHOTOREVISED 1973

AMS 6242 I SE-SERIES V882

KEL-BOR 3/08/96

SECTION 2

SITE BACKGROUND

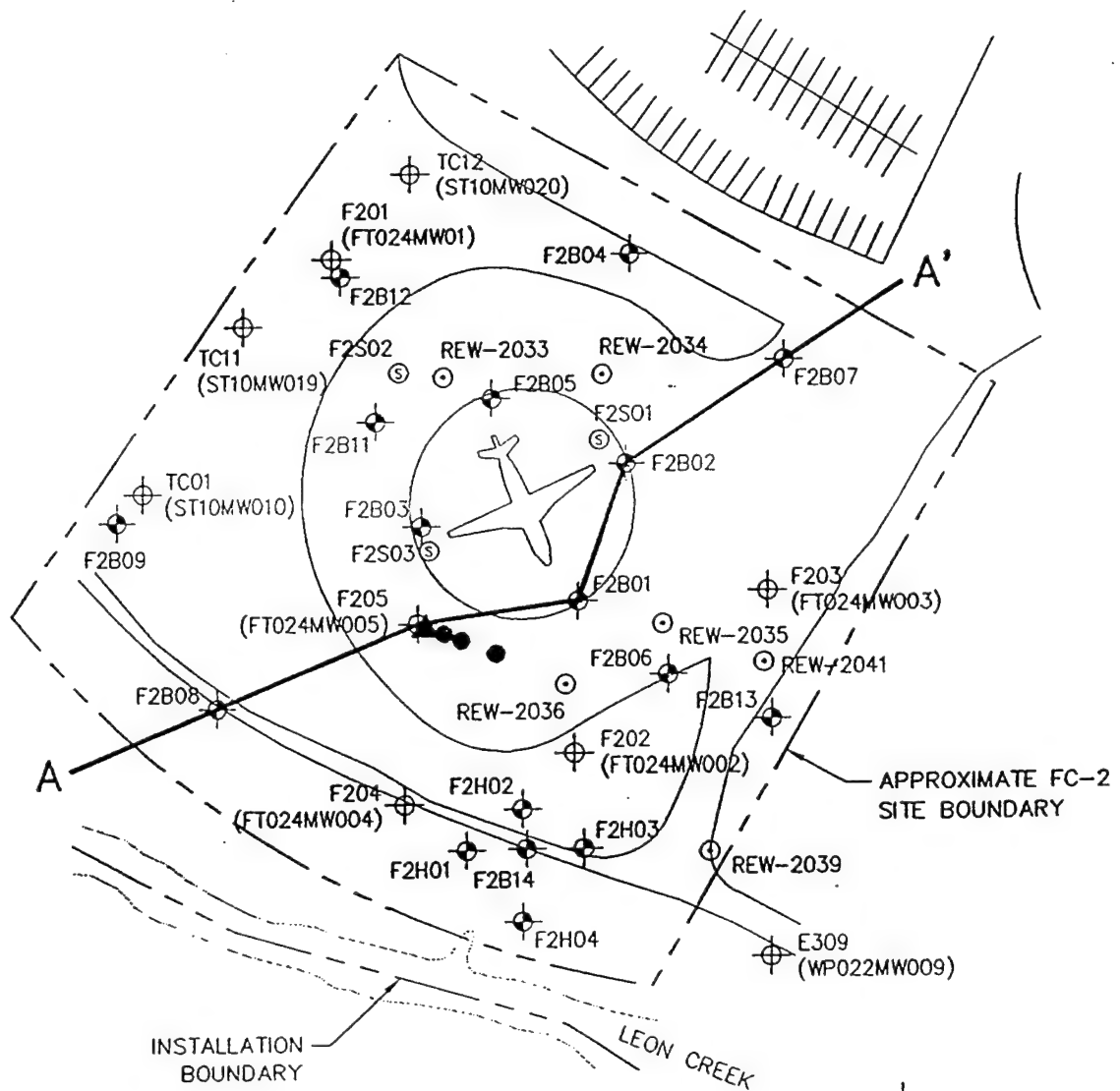
2.1 HISTORY OF SITE FC-2

Site FC-2 consists of a circular area approximately 150 feet in diameter located northwest of the Industrial Waste Sludge Lagoon (Site SA-2) and approximately 100 feet north of Leon Creek. The site layout is presented in Figure 2.1. The area was used from the 1950's to 1981 for fire control training exercises. Waste petroleum, oil, and lubricants (POLs), and fuels were set on fire near the simulated airplane at the center of the site two to four times a year. The fires were extinguished with a water/protein mixture or an aqueous, film-forming foam. No collection facility or oil/water separator (OWS) was used to stop direct infiltration of fuel into the ground. Before any field investigations were performed, the site was regraded with fill material consisting of soils collected from various locations around the base.

2.2 SITE GEOLOGY AND HYDROGEOLOGY

Because the bioventing technology is applied to the unsaturated soils, this section will primarily address soils above the shallow aquifer. A geologic cross section of the site is shown on Figure 2.2 (orientation is on Figure 2.1). Eight to 22 feet of fill material is present over most of Site FC-2 (NUS, 1992). This material is poorly sorted, brown clay to clayey gravel with minor amounts of caliche, sand, and silt. Traces of wood, glass, metal, wire, and assorted construction materials were also encountered. Surficial materials in the top 8 feet consist of fill materials or undisturbed silts and clays. Below these surficial soils, groundwater is encountered in coarse grained sands, gravels or clayey gravels at varying depths of 15 to 18 feet below ground level (bgl). The Navarro clay, a blue-gray to orange brown, mottled dense plastic clay, underlies the coarse-grained sands and gravel. The thickness of the water bearing alluvial/fill material formation ranges from 1 to 11 feet. The soil types across the site appear to be well suited for bioventing treatment by air injection.

Groundwater at Site FC-2 is encountered in the lower coarse-grained sediments described previously, above a thick clay layer of the Navarro formation. The hydraulic gradient at the site is very low, averaging 0.0011 horizontal feet per vertical foot (ft/ft). Groundwater flow in this area is south-southwesterly toward Leon Creek. Slug test data reported by NUS indicates an average hydraulic conductivity of 1.78×10^{-1} centimeters per second (cm/sec) for the alluvial aquifer. Using the average hydraulic conductivity value and assuming an effective porosity of 30 percent, the average seepage flow velocity



NOTE:
CROSS SECTION A-A' SHOWN
ON FIGURE 2.2

LEGEND

- ⊕ EXISTING MONITORING WELL
- EXISTING BIOVENTING MONITORING POINT
- ▲ EXISTING VENT WELL
- ⑤ SURFACE SOIL SAMPLE
- ⊕ INSTALLED SOIL BORING
- GEOPROBE SAMPLE LOCATIONS

FIGURE 2.1

SITE LAYOUT AND GEOLOGIC CROSS SECTION ORIENTATION

Remedial Action Plan
Site FC-2
Kelly AFB, Texas

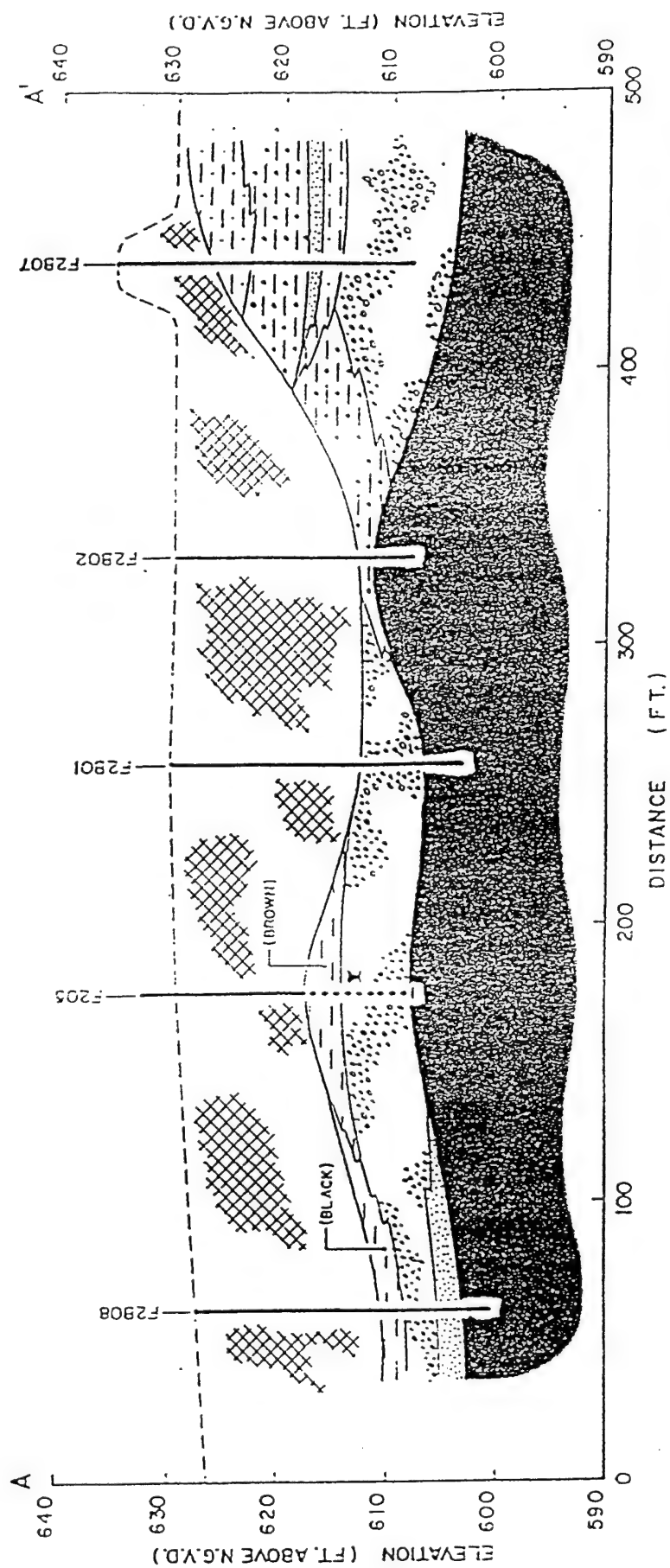
PARSONS
ENGINEERING SCIENCE, INC.

Denver, Colorado

SOUTHWEST

NORTHEAST

KELLY AIR FORCE BASE



Vertical Exaggeration = 4x Horizontal

LEGEND

	SAND		CLAY (BLACK)
	GRAVEL		CLAY (BROWN)
	FILL MATERIAL		NAVARRO CLAY TRANSITION ZONE INT.
	CLAYEY GRAVEL		NAVARRO CLAY

GEOLOGIC CROSS SECTION A-A'

Remedial Action Plan
Site FC-2
Kelly AFB, Texas



PARSONS
ENGINEERING SCIENCE, INC.

Source: Haliburton Nus, 1991.

Denver, Colorado

was calculated to be 1.29 feet per day (ft/day) (NUS, 1992). The northwest to southeast trending Navarro high underlying FC-2 results in significant lateral changes in the saturated thickness of the alluvial aquifer. The thickness of the saturated zone ranges from 4.5 feet (F205) to 15.6 feet (F204). The Navarro Clay acts as a low permeable barrier to vertical migration for the shallow alluvial groundwater, so the primary migration pathway is to Leon Creek.

2.3 SITE CONTAMINANTS

An initial site investigation was conducted by Radian Corporation in 1986. As part of that investigation, Radian drilled three shallow soil borings and collected soil samples from 1 to 2 feet bgl and 4 to 5 feet bgl in each boring. Radian then installed three MWs, F201 (FT024MW001), F202 (FT024MW002), and F203 (FT024MW004), at these boring locations. The findings of the study are included in the Phase II, Stage 2 report (Radian 1988). One shallow soil sample collected from F203 contained trichloroethylene (TCE) at 0.016 milligrams per kilograms (mg/kg) of soil. TRPH contamination ranged from 250 to 10,000 mg/kg in shallow samples, and from 320 to 1300 mg/kg in deeper samples. Petroleum hydrocarbons were detected in all soil samples, to a maximum concentration of 10,000 ppm. A visible sheen of floating product was also encountered on the groundwater at F202. Furthermore, concentrations of some metals were detected at levels above the reported groundwater background levels in the three monitoring wells. Radian's soil investigation assessed soils in the top 5 feet at the site. The position of these sample locations are shown on Figure 2.1.

Roy F. Weston, Inc. collected 13 soil samples in 1990 located within 30 feet of the simulated airplane. These samples were collected throughout the vertical profile of subsurface soils at the site. Low levels of organic compounds were detected in each soil boring.

In 1991, NUS performed a soil gas survey, installed 2 permanent monitoring wells F204 (FT024MW004) and F205 (FT024MW005), drilled 13 soil borings, completed 4 shallow hand auger borings, and collected 3 surface-soil samples to further define contamination at the site. Laboratory results, indicated that much of the VOC, BNA and TPH contamination exists near the center of the fire training area within 100 feet of the simulated plane. Distribution of contamination detected in soil samples from the site is sporadic, with some borings located within 20 feet of each other containing significantly different levels of contamination. These results suggest that contamination may not be uniformly distributed at the site.



NOTE:
CROSS SECTION A-A' SHOWN
ON FIGURE 2.2

LEGEND

- ⊕ EXISTING MONITORING WELL
- EXISTING BIOVENTING MONITORING POINT
- ▲ EXISTING VENT WELL
- ⊙ SURFACE SOIL SAMPLE
- ⊕ INSTALLED SOIL BORING
- ⊙ GEOPROBE SAMPLE LOCATIONS
- ESTIMATED EXTENT OF CONTAMINATED SOIL



FIGURE 2.3

PROBABLE EXTENT OF SOIL CONTAMINATION DESIGNATED FOR REMEDIATION

Remedial Action Plan
Site FC-2
Kelly AFB, Texas



**PARSONS
ENGINEERING SCIENCE, INC.**

Denver, Colorado

Additional soil gas sampling was also performed by Parsons ES in August 1995 to identify portions of subsurface soil that are depleted of oxygen. Oxygen is depleted in portions of the site where data indicate the presence of higher TPH contaminant concentrations. Floating product was observed in MW F202(FT024MW002). The probable extent of contaminated soils designated for remediation is shown on Figure 2.3.

SECTION 3 PROCESS DESCRIPTION

Parsons Engineering Science (Parsons ES) has installed an air injection vent well system consisting of six vent wells at Site FC-2. The blower was started on January 26, 1996 and injected flow rates were adjusted so that the injection rates at each vent well are relatively uniform (9.2 to 12.3 cubic feet per minute).

3.1 SYSTEM DESIGN

The bioventing system includes six vent wells (VWs) for the injection of air. Six monitoring points are provided to monitor soil gas at the site. An as built schematic of the bioventing system is provided in attachment A. The VWs are 2-inches in diameter and screened with 0.040 inch slot from 7 to 19 feet bgl.

The vent wells are manifolded using 2"-diameter, schedule 80 PVC as the conduit for the injected air to flow from the blower to the proposed VWs. The piping is connected to the 2.5 hp regenerative blower that was used for the pilot test and will be set at a depth of 18 inches beneath the ground surface. A separate flow control valve (manual) and flow measurement port are included in the line connecting each VW to allow adjustment of the air flow to each VW. The blower and valving are housed in weatherproof enclosures for protection from the elements and for security purposes.

Based on data collected during the initial pilot test, a maximum injection rate of 10-15 cfm at each VW should be sufficient to supply oxygen to the remaining contaminated soils and sustain *in situ* fuel biodegradation. The radius of oxygen influence around each VW was estimated to extend 50 feet at 10 scfm, based on the data collected during the initial pilot testing. The VW locations were selected to make use of existing monitoring wells and to provide coverage of contaminated soils estimated in Figure 2.3. A spacing of approximately 90 feet between VWs is provided.

SECTION 4

EMISSIONS SUMMARY

The bioventing system installed at the Site FC-2 on Kelly AFB could diffuse VOCs, specifically benzene and TPH, from the surrounding soils. Organic compound emissions from the bioventing project are calculated using the emission factor for soil remediation contained in the Technical Guidance Package for Soil Remediation, TNRCC publication dated October 1995. Analysis of soil gas samples taken from contaminated soils are presented in table 4.1. The average soil gas concentrations of contaminants are 7.5 parts per million volume (ppmv) and 1338.2 ppmv for benzene and TPH respectively.

Vapors within the soil matrix will be diffused at an anticipated average flow rate of 25 standard cubic feet per minute (scfm). This flow rate is intended to maximize the oxygen replacement within the remediated soils.

The assumption that all of the chemical vapors in the soil volume would be displaced to the atmosphere is very conservative since diffusion would actually occur in all directions and not just towards the surface. The worst case emission would take place during the first pore volume displacement and would result in a 0.83 lb/hr discharge of TPH and a 0.002 lb/hr discharge of benzene. Because the initial pore volume will contain the highest volatile concentrations, the rate of emissions from the soil volume will decrease significantly over a period of time.

A bioventing project, located at Kelly AFB, satisfies the requirements of Standard Exemption No. 68. The following is a response to each condition of this standard exemption:

- 68(a) Soil remediation of petroleum hydrocarbons are within the Kelly AFB facility.
- 68(b) Petroleum hydrocarbon emissions do not exceed 1.0 lb/hr. Benzene emissions from the bioventing project also meet the requirements of Standard Exemption 118(c) and (d) as indicated in the emission calculations provided in this document.
- 68(c) The chemical emissions meet the requirements of Standard Exemption 118 (b)-emissions points greater than 100 feet from any off-plant receptor, 118 (c)- all anticipated emissions are well below the respective chemical hourly

Table 4.1
Soil Gas Analytical Results
Kelly AFB, Site FC-2

	Initial Field Screening Data ¹				Laboratory Data				Optimization ² Field Data	
	Purge Time	O ₂ %	CO ₂ %	Field TVH (ppmv)	Benzene (ppmv)	Toluene (ppmv)	Ethyl Benzene (ppmv)	Total Xylene (ppmv)	TPH (ppmv)	O ₂ %
VW 1	5 min	6.5	10	450	NS ³	NS	NS	NS	NS	-
VW 2	1.3 min	0	13	400	NS	NS	NS	NS	NS	-
VW 3	5 min	5.5	11	400	NS	NS	NS	NS	NS	-
VW 4	7 min	14	11	900	NS	NS	NS	NS	NS	-
VW 5	6 min	16	4	300	NS	NS	NS	NS	NS	-
VW 6	5 min	13	7	500	NS	NS	NS	NS	NS	-
MPA-4	30 sec	15	4	200	NS	NS	NS	NS	NS	20.8
MPA-9	30 sec	9	9	200	NS	NS	NS	NS	NS	19.5
MPA-13	30 sec	10	3	450	NS	NS	NS	NS	NS	13
MPB-4	30 sec	16	4.5	150	NS	NS	NS	NS	NS	16.5
MPB-9	30 sec	1	12	300	NS	NS	NS	NS	NS	4.5
MPB-13.5	30 sec	18	1	150	NS	NS	NS	NS	NS	0.5
MPC-4	30 sec	17.5	2.5	100	NS	NS	NS	NS	NS	6
MPC-9	30 sec	0	15	5000	NS	NS	NS	NS	NS	0
MPC-13.5	30 sec	0	15	> 10,000	NS	NS	NS	NS	NS	0
MPD-4	30 sec	17	2.5	1000	0.3	0.14	0.036	0.58	97	0
MPD-9	30 sec	4	5	1100	NS	NS	NS	NS	NS	0
MPD-13.5	30 sec	0	15	5000	37	5.2	1.4	3.2	6300	0
MPE-4	30 sec	15	5	20	0.005	0.009	0.003	0.12	14	8
MPE-9	30 sec	4	8.5	40	0.21	0.22	< 0.18	0.43	170	11.5
MPE-13.5	30 sec	1	14	80	0.067	0.13	< 0.022	1.1	110	11
MPF-4	30 sec	19	1.5	40	NS	NS	NS	NS	NS	20.8
MPF-9	30 sec	5	8.5	100	NS	NS	NS	NS	NS	16
MPF-13.5	H ₂ O ⁴	H ₂ O	H ₂ O	H ₂ O	NS	NS	NS	NS	NS	1.5
FT024/MW003	1 min	0	13	500	NS	NS	NS	NS	NS	-
FT024/MW002	5 min	1.5	16	6000	NS	NS	NS	NS	NS	-
F204	3 min	15.5	4.5	300	NS	NS	NS	NS	NS	-

¹ Data collected on January 17, 1996

² Data collected on March 6, 1996, after 3 weeks of continuous air injection at approximately 11 cfm

³ NS - No laboratory sample collected

⁴ Monitoring point interval saturated with water
NS - No Laboratory Sample Collected

emission rate limits as indicated in the emission calculations provided in this document.

- 68(d) The treatment project will not involve the handling (screening, crushing, etc.) of contaminated soil or remediated soil; therefore, this requirement does not apply.
- 68(e) An abatement device is not necessary to meet the emission limits; therefore, this requirement does not apply.
- 68(f) A form PI-7 for the Site FC-2 bioventing project will be registered with the Texas Natural Resource Conservation Commission (TNRCC) office of Air Quality. Specific information concerning the basis of maximum estimated emissions can be found in the emission calculations provided in this document.
- 68(g) A copy of the Form PI-7 and the supporting data will be maintained at the site. These records will be available for inspection and retained for at least two years following the date of this standard exemption application.

SECTION 5

EMISSION CALCULATIONS

Emissions are calculated by using known soil gas concentrations, an assumed air flow and physical characteristics of the air pollutants. The emission rate (lb/hr) = (contaminant concentration in ppmv) x (contaminants molecular weight in lb/lb-mole) x (air pump rate in cubic feet per minute) x $(1.581 \times 10^{-7} \text{ lb-mole-min./ft}^3\text{-ppmv-hr})$. Table 5.1 presents the emissions estimates for the bioventing system which includes the assumption that all displaced soil vapors will be emitted into the atmosphere.

Standard Exemption 118(c) for chemical constituent emissions (E) is calculated by using the equation $E = L/K$, where L and K are the value as listed in table 118A of the TNRCC standard exemption list. Table 5.2 presents the results of speciated emission rates and their respective Standard Exemption requirements.

Table 5.1

Bioventing Benzene Air Pollutant Emission Estimate for Kelly AFB
 Component Benzene and TPH
 Emission Factor Source: Technical Guidance Package for Soil Remediation,
 TNRCC Publication, dated October 1995
 Emission Controls: None

Formulas

$E = C_a * MW_{\text{constituent}} * A_v * C$
 C_a = analytical soil gas concentrations by volume (ppmv) are known, or
 $C_a = (C_T * H' * B) / ((K_d * B) + e_w + e_a * H_c)$ if soil concentrations by weight (ppmw) are known
 $H' = H_c / RT$
 $K_d = K_{oc} * f_{oc}$

<u>Parameter Name</u>	<u>Symbol</u>	<u>Value</u>	<u>Data Source/notes</u>
soil vapor concentration (mg/l)	C_{benzene}	7.50	analytical
soil vapor concentration (mg/l)	C_{TPH}	1338.20	analytical
molecular weight. benzene (lb/lb-mole)	MW_{benzene}	78	benzene
molecular weight. TPH (lb/lb-mole)	MW_{TPH}	165	TPH reference to Jet Fuel
air flow rate (ft ³ /min)	A_v	25	air pumping rate
factor (lb-mole min/ft ³ ppmv hr)	C	1.58E-07	conversion factor
emission rate, benzene (lb/hr)	E_{benzene}	2.31E-03	
emission rate, TPH (lb/hr)	E_{TPH}	8.73E-01	

Table 5.2
Speciated Air Emission Rate Requirements

Bioventing Benzene Air Pollutant Emission Requirements for Kelly AFB
Component Benzene and TPH
Emission Factor Source: TNRCC Standard Exemption 118,

Emission Controls: None

$$\begin{aligned} E &= L/K \text{ (lb/hr)} \\ L &= 3 \text{ for benzene} \\ K &= 326 \end{aligned}$$

$$E_{\text{benzene}} = 0.009202$$